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SCIENTIFIC OPINION

Scientific Opinion on the public health hazards to be covered by inspection of meat (poultry)[1]

EFSA Panel on Biological Hazards (BIOHAZ)[2, 3]

EFSA Panel on Contaminants in the Food Chain (CONTAM)[4, 5]

EFSA Panel on Animal Health and Welfare (AHAW)[6, 7]

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

A qualitative risk assessment identified *Campylobacter* spp., *Salmonella* spp. and ESBL/AmpC gene-carrying bacteria as the most relevant biological hazards in the context of meat inspection of poultry. As none of these are detected by traditional visual meat inspection, establishing an integrated food safety assurance system, achievable through improved food chain information (FCI) and risk-based interventions, was proposed. This includes setting targets at carcass level and, when appropriate, flock level indicating what should be achieved for a given hazard. Elements of the system would be risk categorisation of flocks based on FCI and classification of abattoirs according to their capability to reduce carcass faecal contamination. It is proposed that *post-mortem* visual inspection is replaced by setting targets for the main hazards on the carcass, and by verification of the

[1] On request from the European Commission. Question Nos. EFSA-Q-2010-01469, EFSA-Q-2011-00110 and EFSA-Q-2011-00019 adopted on 23 May 2012.

[2] BIOHAZ Panel members: Olivier Andreoletti, Herbert Budka, Sava Buncic, John D Collins (posthumous), John Griffin, Tine Hald, Arie Havelaar, James Hope, Günter Klein, Kostas Koutsoumanis, James McLauchlin, Christine Müller-Graf, Christophe Nguyen-The, Birgit Noerrung, Luisa Peixe, Miguel Prieto Maradona, Antonia Ricci, John Sofos, John Threlfall, Ivar Vågsholm and Emmanuel Vanopdenbosch. Correspondence: biohaz@efsa.europa.eu

[3] Acknowledgement: The BIOHAZ Panel wishes to thank the members of the Working Group on the public health hazards to be covered by inspection of meat from poultry: Rob Davies, Arie Havelaar, Tine Hald, Coralie Lupo, Birgit Noerrung and Antonia Ricci for the preparatory work on this scientific opinion and ECDC staff: Vicente Lopez and EFSA staff: Pablo Romero-Barrios, Giusi Amore and Ernesto Liebana for the support provided to this scientific opinion.

[4] CONTAM Panel members: Jan Alexander, Diane Benford, Alan Boobis, Sandra Ceccatelli, Bruce Cottrill, Jean-Pierre Cravedi, Alessandro Di Domenico, Daniel Doerge, Eugenia Dogliotti, Lutz Edler, Peter Farmer, Metka Filipič, Johanna Fink-Gremmels, Peter Fürst, Thierry Guérin, Helle Katrine Knutsen, Miroslav Machala, Antonio Mutti, Josef Schlatter, Martin Rose and Rolaf van Leeuwen. Correspondence: contam@efsa.europa.eu

[5] Acknowledgement: The CONTAM Panel wishes to thank the members of the Working Group on meat inspection and contaminants: Johanna Fink-Gremmels, Reinhard Fries, Peter Fürst, Steve Mcorist and Michael O'Keeffe for the preparatory work on this scientific opinion and EFSA staff: Silvia Inés Nicolau Solano and Valeriu Curtui for the support provided to this scientific opinion.

[6] AHAW Panel members: Anette Bøtner, Donald Broom, Marcus G. Doherr, Mariano Domingo, Jörg Hartung, Linda Keeling, Frank Koenen, Simon More, David Morton, Pascal Oltenacu, Albert Osterhaus, Fulvio Salati, Mo Salman, Moez Sanaa, James M. Sharp, Jan A. Stegeman, Endre Szücs, Hans-H. Thulke, Philippe Vannier, John Webster and, Martin Wierup. Correspondence: ahaw@efsa.europa.eu

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food business operator's hygiene management, using Process Hygiene Criteria. Chemical substances that might occur in poultry were ranked into four categories of potential concern based on pre-defined criteria. Dioxins, dioxin-like polychlorinated biphenyls, chloramphenicol, nitrofurans and nitroimidazoles were ranked as being of high potential concern. Chemical substances in poultry, however, are unlikely to pose an immediate or acute health risk for consumers. Sampling for chemical residues and contaminants should be based on the available FCI. Moreover, control programmes should be better integrated with feed controls and regularly updated to include new and emerging substances. Meat inspection is recognised as a valuable tool for surveillance and monitoring of specific animal health and welfare conditions. If visual *post-mortem* inspection is removed, other approaches should be applied to compensate for the associated loss of information on the occurrence of animal disease and welfare conditions. Extended use of FCI has the potential to compensate for some, but not all, of the information on animal health and welfare that would be lost if visual *post-mortem* inspection is removed.

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KEY WORDS

Meat inspection, poultry, slaughterhouse, surveillance, safety, *ante-mortem*, *post-mortem*, contaminants, residues

SUMMARY

Following a request from the European Commission to EFSA, the Panel on Biological Hazards (BIOHAZ) and the Panel on Contaminants in the Food Chain (CONTAM) were asked to deliver a Scientific Opinion on the public health hazards (biological and chemical, respectively) to be covered by inspection of poultry meat. Briefly, these Panels were asked to identify and rank the main risks for public health that should be addressed by meat inspection, to assess the strengths and weaknesses of the current meat inspection methodology, to recommend inspection methods fit for the purpose of meeting the overall objectives of meat inspection for hazards currently not covered by the meat inspection system, and to recommend adaptations of inspection methods and/or frequencies of inspections that provide an equivalent level of protection. In addition, the Panel on Animal Health and Welfare (AHAW) was asked to consider the implications for animal health and animal welfare of any changes proposed to current meat inspection methods. The three EFSA Panels presented the following key conclusions and recommendations:

For biological hazards, a decision tree was developed and used for risk ranking poultry meat-borne hazards. The ranking was based on the magnitude of the human health impact, the severity of the disease in humans, the proportion of human cases that can be attributed to the handling, preparation and consumption of poultry meat, and the occurrence of the hazards in poultry flocks and carcasses. *Campylobacter* spp. and *Salmonella* spp. were considered to be of high public health relevance for poultry meat inspection. Extended spectrum β-lactamase (ESBL)/AmpC gene-carrying bacteria were considered to be of medium to high (*E. coli*), and low to medium (*Salmonella*) public health relevance. Data for ranking *C. difficile* were insufficient, but based on the limited information available, the risk at the present time was considered to be low. All other hazards were considered to be of low public health relevance.

Risk ranking of chemical hazards was based on the outcome of the National Residue Control Plans (NRCPs) as defined in Council Directive 96/23/EC[8] for the period 2005-2010, as well as on substance-specific parameters such as the toxicological profile and the likelihood of the occurrence of residues in poultry. Dioxins, dioxin-like polychlorinated biphenyls (DL-PCBs), and the banned antibiotics chloramphenicol, nitrofurans and nitroimidazoles were ranked as being of high potential concern; all other substances were ranked as of medium or lower concern. Based on the low percentage of non-compliant results reported by the NRCPs for the studied period of six years, it was concluded that chemical substances in poultry are unlikely to pose an immediate or acute health risk for consumers.

It should be noted that the ranking into specific risk categories of both biological and chemical hazards is based on current knowledge and available data and therefore mainly applies to broilers and turkeys.

The assessment of the strengths and weaknesses of current meat inspection regarding biological hazards focused on the public health risks that may occur through the handling, preparation and/or consumption of poultry meat. Strengths identified were that Food Chain Information (FCI), as part of *ante-mortem* inspection, provides information related to disease occurrence during rearing and veterinary treatments, enabling a focused *ante-mortem* inspection on flocks with animal health concerns. *Ante-mortem* inspection can be used to verify FCI given by the farmer and to provide feedback to producers on problems detected, which are mainly issues not related to public health. In addition, visual inspection of live animals can detect birds heavily contaminated with faeces. Such birds increase the risk of cross-contaminating carcasses with hazards during slaughter and may consequently constitute a food safety risk that can be reduced if such birds/carcasses are dealt with adequately. Visual detection of faecal contamination of carcasses at *post mortem* inspection can also be an indicator of slaughter hygiene, but other approaches to verify slaughter hygiene are considered more appropriate.

[8] Council Directive 96/23/EC of 29 April 1996 on measures to monitor certain substances and residues thereof in live animals and animal products and repealing Directives 85/358/EEC and 84/469/EEC and Decisions 89/187/EEC and 91/664/EEC. OJ L 125, 23.5.1996, p. 10-32.

With regard to chemical hazards, it was noted that current procedures for sampling and testing are in general well-established and co-ordinated, including follow-up mechanisms following identification of non-compliant samples. The current system is well-endorsed by sector stakeholders, and the regular sampling and testing for chemical residues and contaminants is a disincentive for the development of undesirable practices. Moreover, the prescriptive sampling system allows for equivalence to be achieved for European Union (EU) domestic poultry.

The following food safety-related weaknesses in the field of biological hazards were identified: FCI lacks adequate and standardised indicators for the main public health hazards except for *Salmonella* in broiler and turkey flocks. Current *ante-mortem* and *post-mortem* visual inspection are not able to detect any of the public health hazards identified as the main concerns for food safety. *Ante-mortem* examination is carried out only on birds in a sample of crates and the observation of individual birds in the crates is difficult. The high speed of the slaughter lines reduces the sensitivity of detection of lesions or faecal carcass contamination by visual inspection and only, at best, a sample of the birds can be thoroughly examined. For the chemical hazards, a major weakness is the limited value of the visual *ante-mortem* and *post-mortem* inspection for the identification of chemical residues and contaminants. In addition, NRCPs prescribe the number of samples that need to be taken, but do not necessarily take into account actual FCI related to feed control and environmental monitoring of substances of potential health concern. A further integration and exchange of information between these different activities is recommended.

As none of the main biological hazards of public health relevance and associated with poultry meat can be detected by traditional visual meat inspection, the BIOHAZ Panel proposes the establishment of an integrated food safety assurance system achievable through improved FCI and interventions based on risk. This includes clear and measurable targets at carcass level and, when appropriate, flock level indicating what food business operators (FBOs) should achieve in respect to a particular hazard. An important element of an integrated food safety assurance system is risk categorisation of poultry flocks based on FCI. In addition to flock-specific information, farm descriptors provided through farm audits could be included to assess the risk and protective factors for the flocks related to the given hazards. Classification of abattoirs according to their capability to prevent or reduce faecal contamination of carcasses can be based on the technologies applied including installed equipment and the hazard analysis and critical control points (HACCP) programmes in place and/or on the process hygiene as measured by for example the level of indicator organisms such as *E. coli* or *Enterobacteriaceae* on the carcasses, i.e. establishment of Process Hygiene Criteria (PHC). The differentiation of abattoirs could provide a way of sending flocks presenting specific risk levels to adapted slaughter lines or abattoirs.

In conclusion, for biological hazards it was assessed that a wider, more systematic and better focused use of the FCI will have positive impact on control of the main public health hazards associated with poultry meat. *Ante-mortem* inspection of poultry can help to detect birds heavily contaminated with faeces and to assess the general health status of the flock. No adaptations to the existing visual *ante-mortem* inspection are found to be required. In contrast, it is proposed that the current *post-mortem* visual inspection is replaced by the establishment of targets for the main hazards on the carcass and by verification of the FBO's own hygiene management through the use of PHC. It is noted though, that current *post-mortem* inspection does not increase the microbiological risk to public health unless the carcasses are handled as a consequence of the visual detection of abnormalities, leading to cross-contamination. A series of recommendations were made regarding biological hazards on data collection, interpretation of monitoring results, future evaluations of the meat inspection system and hazard identification/ranking, training of all parties involved in the poultry carcass safety assurance system, and needs for research on optimal ways to use FCI and approaches for assessing the public health benefits.

The risk profile for individual farms and poultry species regarding chemical hazards varies due to the diversity of poultry farming in the EU. It was recommended that sampling of poultry carcasses should be based on the available FCI, including results from feed controls. Frequency of sampling for farms

should be adjusted accordingly and should be regularly updated in order to include new and emerging substances. Dioxins and DL-PCBs were considered as "new" chemical hazards as they were ranked as being of high potential concern, but have not yet been comprehensively covered by the sampling plans (NRCPs) of the current meat inspection. For a number of other organic contaminants that also may accumulate in food-producing animals, very limited data regarding residues in poultry are available. This is the case, in particular, for non dioxin-like polychlorinated biphenyls, brominated flame retardants, including polybrominated diphenylethers and hexabromocyclododecanes. The potential occurrence of these substances in poultry carcasses should be monitored to improve human exposure assessment.

Complementary to the assessment of consumer's health risks, implications for animal health and welfare of the proposed changes to the meat inspection system were investigated, particularly the omission of visual *post-mortem* inspection and extensive use of FCI. Two broad methods were used during this assessment, including a qualitative approach (review of scientific literature, expert opinion) and results from quantitative modelling.

In the meat inspection system, *ante-* and *post-mortem* inspection are recognised as valuable tools for surveillance and monitoring of specific animal health and welfare issues. Meat inspection is often a key point for identifying outbreaks of existing or new disorders or disease syndromes in situations where clinical signs are not detected on-farm. In the course of normal commercial procedures, *ante-* and *post-mortem* inspection of poultry is an appropriate and practical way to evaluate the welfare of poultry on-farm, and the only way to evaluate the welfare of poultry during transport and associated handling.

Two key consequences of omission of visual *post-mortem* inspection on surveillance and monitoring for poultry health and welfare were identified: the loss of opportunities for data collection about the occurrence of existing or new disorders or disease syndromes or welfare conditions of poultry, and the potential for carcasses with pathological changes, currently condemned during visual *post-mortem* inspection, to be further processed without the infectious nature of some conditions being detected.

If visual *post-mortem* inspection is removed, other approaches should be explored and applied to compensate for any associated loss of information about the occurrence of animal disease and welfare conditions. Two approaches are outlined. Firstly, it is recommended that *post-mortem* checks continue on each carcass that is removed from the food chain, as part of a meat quality assurance system for example, due to visible pathological changes or other abnormalities. In addition, it is proposed that detailed inspection is conducted on a defined subset of carcasses from each batch, guided by FCI and other epidemiological criteria, to obtain information about animal disease and welfare conditions. The intensity (number of birds sampled) of targeted surveillance within each batch should be risk-based, with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch.

Extended use of FCI has the potential to compensate for some, but not all, of the information on animal health and welfare that would be lost if visual *post-mortem* inspection is removed. This can only occur if FCI are designed to identify indicators for the occurrence of animal health and welfare conditions. FCI for public health purposes may not have an optimal design for surveillance and monitoring of animal health and welfare; therefore, an integrated system should be developed where FCI for public health and for animal health and welfare can be used in parallel.

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

Regulation (EC) No 854/2004 of the European Parliament and of the Council lays down specific rules for the organisation of official controls on products of animal origin intended for human consumption.[9] Inspection tasks within this Regulation include:

- Checks and analysis of food chain information
- *Ante-mortem* inspection
- Animal welfare
- *Post-mortem* inspection
- Specified risk material and other by-products
- Laboratory testing

The scope of the inspection includes monitoring of zoonotic infections and the detection or confirmation of certain animal diseases without necessarily having consequences for the placing on the market of meat. The purpose of the inspection is to assess if the meat is fit for human consumption in general and to address a number of specific hazards: in particular the following issues: transmissible spongiform encephalopathies (only ruminants), cysticercosis, trichinosis, glanders (only solipeds), tuberculosis, brucellosis, contaminants (e.g. heavy metals), residues of veterinary drugs and unauthorised substances or products.

During their meeting on 6 November 2008, Chief Veterinary Officers (CVO) of the Member States agreed on conclusions on modernisation of sanitary inspection in slaughterhouses based on the recommendations issued during a seminar organised by the French Presidency from 7 to 11 July 2008. The CVO conclusions have been considered in the Commission Report on the experience gained from the application of the Hygiene Regulations, adopted on 28 July 2009. Council Conclusions on the Commission report were adopted on 20 November 2009 inviting the Commission to prepare concrete proposals allowing the effective implementation of modernised sanitary inspection in slaughterhouses while making full use of the principle of the 'risk-based approach'.

In accordance with Article 20 of Regulation (EC) No 854/2004, the Commission shall consult EFSA on certain matters falling within the scope of the Regulation whenever necessary.

EFSA and the Commission's former Scientific Committee on Veterinary Measures relating to Public Health have issued in the past a number of opinions on meat inspection considering specific hazards or production systems separately. In order to guarantee a more risk-based approach, an assessment of the risk caused by specific hazards is needed, taking into account the evolving epidemiological situation in Member States. In addition, methodologies may need to be reviewed taking into account risks of possible cross-contamination, trends in slaughter techniques and possible new inspection methods.

TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

The scope of this mandate is to evaluate meat inspection in order to assess the fitness of the meat for human consumption and to monitor food-borne zoonotic infections (public health) without jeopardizing the detection of certain animal diseases nor the verification of compliance with rules on animal welfare at slaughter. If and when the current methodology for this purpose would be considered not to be the most satisfactory to monitor major hazards for public health, additional methods should be recommended as explained in detail under points 2 and 4 of the terms of reference. The objectives of the current legal provisions aimed at carrying out meat inspection on a risk-based analysis should be maintained.

[9] OJ L 226, 25.6.2004, p. 83.

In order to ensure a risk-based approach, EFSA is requested to provide scientific opinions on meat inspection in slaughterhouses and, if considered appropriate, at any other stages of the production chain, taking into account implications for animal health and animal welfare in its risk analysis. In addition, relevant international guidance should be considered, such as the Codex Code of Hygienic Practice for Meat (CAC/RCP 58-2005), and Chapter 6.2 on Control of biological hazards of animal health and public health importance through *ante-* and *post-mortem* meat inspection, as well as Chapter 7.5 on slaughter of animals of the Terrestrial Animal Health Code of the World Organization for Animal Health (OIE).

The following species or groups of species should be considered, taking into account the following order of priority identified in consultation with the Member States: domestic swine, poultry, bovine animals over six weeks old, bovine animals under six weeks old, domestic sheep and goats, farmed game and domestic solipeds.

In particular, EFSA, in consultation with the European Centre for Disease Prevention and Control (ECDC), is requested within the scope described above to:

1. Identify and rank the main risks for public health that should be addressed by meat inspection at EU level. General (e.g. sepsis, abscesses) and specific biological risks as well as chemical risks (e.g. residues of veterinary drugs and contaminants) should be considered. Differentiation may be made according to production systems and age of animals (e.g. breeding compared to fattening animals).

2. Assess the strengths and weaknesses of the current meat inspection methodology and recommend possible alternative methods (at *ante-mortem* or *post-mortem* inspection, or validated laboratory testing within the frame of traditional meat inspection or elsewhere in the production chain) at EU level, providing an equivalent achievement of overall objectives; the implications for animal health and animal welfare of any changes suggested in the light of public health risks to current inspection methods should be considered.

3. If new hazards currently not covered by the meat inspection system (e.g. *Salmonella*, *Campylobacter*) are identified under terms of reference (TOR) 1, then recommend inspection methods fit for the purpose of meeting the overall objectives of meat inspection. When appropriate, food chain information should be taken into account.

4. Recommend adaptations of inspection methods and/or frequencies of inspections that provide an equivalent level of protection within the scope of meat inspection or elsewhere in the production chain that may be used by risk managers in case they consider the current methods disproportionate to the risk, e.g. based on the ranking as an outcome of terms of reference 1 or on data obtained using harmonised epidemiological criteria (see annex 2[10]). When appropriate, food chain information should be taken into account.

[10] Annex 2 of the original European Commission mandate.

APPROACH TAKEN TO ANSWER THE TERMS OF REFERENCE

1. Scope

The scope of the mandate is to evaluate meat inspection in a public health context; animal health and welfare issues will be covered in respect to the possible implications of adaptations/alterations to current inspection methods, or the introduction of novel inspection methods proposed by this mandate.

Issues other than those of public health significance but that still compromise fitness of the meat for human consumption (Regulation (EC) No 854/2004,[11] Annex I, Section II, Chapter V) are outside the scope of the mandate. Examples of these include sexual odour ('boar taint'). Transmissible spongiform encephalopathies are also outside the scope of the mandate.

The impact of changes to meat inspection procedures on occupational health of abattoir workers, inspectors, etc. is outside the scope of the mandate. Additionally, biological hazards representing primarily occupational health risk, the controls related to any biological hazards at any meat chain stage beyond abattoir, and the implications for environmental protection, are not dealt with in this document.

2. Approach

In line with Article 20 of Regulation (EC) No 854/2004[11] the European Commission has recently submitted a mandate to EFSA (M-2010-0232) to cover different aspects of meat inspection. The mandate comprises two requests: one for Scientific Opinions and one for Technical Assistance.

EFSA is requested to issue scientific opinions related to inspection of meat in different species. In addition, technical assistance have also been requested on harmonised epidemiological criteria for specific hazards for public health that can be used by risk managers to consider adaptation of meat inspection methodology.

Meat inspection is defined by Regulation 854/2004.[11] The species or groups of species to be considered are: domestic swine, poultry, bovine animals over six weeks old, bovine animals under six weeks old, domestic sheep and goats, farmed game and domestic solipeds.

Taking into account the complexity of the subject and that consideration has to be given to zoonotic hazards, animal health and welfare issues, and to chemical hazards (e.g. residues of veterinary drugs and chemical contaminants), the involvement of several EFSA Units was necessary. More specifically, the mandate was allocated to the Biological Hazards (BIOHAZ), Animal Health and Welfare (AHAW) and Contaminants in the Food Chain (CONTAM) Panels, and to the Biological Monitoring (BIOMO), Scientific Assessment Support (SAS), and Dietary & Chemical Monitoring (DCM) Units of the Risk Assessment & Scientific Assistance Directorate for the delivery of the Scientific Opinion, and of the Technical Assistance, respectively.

This Scientific Opinion therefore concerns the assessment of meat inspection in poultry, and it includes the answer to the terms of reference proposed by the European Commission. Due to the complexity of the mandate, the presentation of the outcome does not follow the usual layout. For ease of reading, main outputs from the three Scientific Panels (BIOHAZ, CONTAM and AHAW) are presented at the beginning of the document. The scientific justifications of these outputs are found in the various Appendices as adopted by their respective Panels, namely biological hazards (Appendix A), chemical hazards (Appendix B), and the potential impact that the proposed changes envisaged by these two could have on animal health and welfare (Appendix C).

[11] Regulation (EC) No. 854/2004 of the European Parliament and of the Council of 30 April 2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption. OJ L 139, 30.4.2004, p. 206. Corrigendum. OJ L 226, 25.6.2004, p. 83-127.

CONCLUSIONS AND RECOMMENDATIONS ANSWERING THE TERMS OF REFERENCE

CONCLUSIONS

1. TOR 1. ***To identify and rank the main risks for public health that should be addressed by meat inspection at EU level. General (e.g. sepsis, abscesses) and specific biological risks as well as chemical risks (e.g. residues of veterinary drugs and contaminants) should be considered. Differentiation may be made according to production systems and age of animals (e.g. breeding compared to fattening animals).***

Conclusions BIOHAZ Panel

- A decision tree was developed and used for risk ranking poultry meat-borne biological hazards. Hazards that are introduced and/or for which the risk to public health relates to growth that occurs during processing steps after carcass chilling were not considered. The risk ranking was based on the following criteria: (I) the magnitude of the human health impact; (II) the severity of the disease in humans; (III) the proportion of human cases that can be attributable to the handling, preparation and/or consumption of poultry meat; and (IV) the occurrence (prevalence) of the identified hazards in poultry flocks and carcasses. The risk ranking did not consider the different poultry species separately.

- Based on the risk ranking, the hazards were classified as follows:

  – *Campylobacter* spp. and *Salmonella* spp. were considered of high public health relevance for poultry meat inspection.

  – Extended spectrum β-lactamase (ESBL)/AmpC gene-carrying bacteria were considered to be of medium to high (*E. coli*) and low to medium (*Salmonella*) public health relevance.

  – In the case of *C. difficile*, data for ranking were insufficient, but, based on the limited information available, the Panel assessed the risk at the present time to be low.

  – The remaining identified hazards were considered to be of low public health relevance, based on available data. For the low-risk hazards, no hazard-specific control measures are currently implemented at the farm and/or slaughterhouse level. These hazards were therefore not considered further.

Conclusions CONTAM Panel

- As a first step in the identification and ranking of chemical substances of potential concern, the EFSA Panel on Contaminants in the Food Chain (CONTAM Panel) considered substances listed in Council Directive 96/23/EC[8] and evaluated the outcome of the residue monitoring plans for the period 2005-2010. The CONTAM Panel noted that only approximately 0.27 % of the total number of results was non-compliant for one or more substances listed in Council Directive 96/23/EC[8] and thus chemical substances in poultry are unlikely to pose an immediate or acute health risk for consumers. Consequently, potentially higher exposure of consumers to these residues from poultry or poultry products takes place only incidentally, as a result of mistakes or non-compliance with known and regulated procedures. However, in the absence of substance-specific information, such as the tissues used for residue analysis and the actual concentration of a residue or contaminant measured, these data do not allow a reliable assessment of consumer exposure.

- The highest overall proportion of non-compliant results under the National Residue Control Plans (NRCPs) were for Group B1/B2 substances (0.51 %) representing largely exceedances of the maximum residue limits (MRLs) specified for these substances. The lowest proportion

of non-compliant results overall (0.05 %) were for Group A substances representing largely illicit use of these substances. The intermediate proportion of non-compliant results was for Group B3 substances (0.21 %), representing largely exceedances of the MRLs/maximum levels (MLs) specified for these substances.

- Criteria used for the identification and ranking of chemical substances of potential concern included the identification of substances that accumulate in food-producing animals, substances with a specific toxicological profile, and the likelihood that a substance under consideration will occur in poultry. Taking into account these criteria the individual contaminants were ranked into four categories denoted as of high, medium, low and negligible potential concern.
- Dioxins and dioxin-like polychlorinated biphenyls (DL-PCBs) were ranked as being of high potential concern due to their known accumulation in food-producing animals, the risk of exceedance of maximum levels, and in consideration of their toxicological profile.
- Chloramphenicol and the groups of nitrofurans and nitroimidazoles were ranked as being of high potential concern, as they have a distinct toxicological profile comprising a potential concern for human health and residues in poultry have been found in the course of the NRCPs in various Member States (MSs), although these substances are prohibited for use in food-producing animals in the European Union.
- Non dioxin-like polychlorinated biphenyls (NDL-PCBs), polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDDs) also accumulate in food-producing animals, but were ranked in the category of medium potential concern, because they are less toxic than dioxins and DL-PCBs. Occurrence data are required for all poultry species to confirm or refute this ranking, in particular for PBDEs and HBCDDs.
- Residues originating from other substances listed in Council Directive 96/23/EC[8] were ranked in the low or negligible potential concern category due to the low toxicological profile of residues of these compounds and the absence or seldom association with exceedances in MRLs or MLs. This category includes, among others, organochlorine and organophosphorus compounds, chemical elements, mycotoxins, natural plant toxins, as well as residues of veterinary medicinal products, anticoccidials, and prohibited substances such as chlorpromazine, dapsone, resorcylic acid lactones, stilbenes, thyreostats, *beta*-agonists and steroids.
- The CONTAM Panel emphasises that this ranking into specific categories of potential concern mainly applies to broilers and turkeys and is based on current knowledge regarding the toxicological profiles, usage in poultry husbandry and likelihood of occurrence of residues and contaminants in edible tissues of poultry.
- Differences in animal husbandry practices (indoor vs. outdoor), feed supply (industrial vs. home-produced feed) and life-span of the poultry categories (from just over 1 month for broilers to 3-6 months or even 18 months for spent hens) can result in a different likelihood of occurrence of particular residues and contaminants.
- It is to be noted that there is a lack of detail provided on results, in particular for non-compliant samples, for the NRCP from MSs. This hampers the interpretation and the evaluation of data.

2. TOR 2. ***To assess the strengths and weaknesses of the current meat inspection methodology and recommend possible alternative methods (at* ante-mortem *or* post-mortem *inspection, or validated laboratory testing within the frame of traditional meat inspection or elsewhere in the production chain) at EU level, providing an equivalent achievement of overall objectives; the implications for animal health and animal welfare of any changes suggested in the light of public health risks to current inspection methods should be considered.***

Conclusions BIOHAZ Panel

- The main elements of the current poultry meat inspection are analysis of food chain information (FCI), *ante-mortem* examination of animals, and *post-mortem* examination of carcasses and organs. The assessment of the strengths and weaknesses of the current meat inspection was focused on the public health risks that may occur through the handling, preparation and/or consumption of poultry meat.

Strengths

- FCI is being used as part of *ante-mortem* inspection and provides in particular information related to veterinary treatments and disease occurrence during rearing helps focus the *ante-mortem* inspection on flocks with an animal health concern. Currently in the EU, the use of FCI for microbial food safety purposes is limited to *Salmonella* control, where it provides a valuable tool for risk management decision making.

- *Ante-mortem* inspection can be used to verify FCI given by the farmer and to provide feedback to producers on problems detected, but usually for issues not related to public health.

- Visual inspection of live animals can detect birds heavily contaminated with faeces. Such birds increase the risk of cross-contamination during slaughter and may consequently constitute a food safety risk. If such birds/carcasses are dealt with adequately, this risk can be reduced.

- Visual detection of faecal contamination of carcasses at *post-mortem* inspection can also be an indicator of slaughter hygiene, but other approaches to verify slaughter hygiene are considered more appropriate.

Weaknesses

- In practice, FCI lacks adequate and standardised indicators for the main public health hazards identified. Exceptions are the results of the harmonised monitoring of *Salmonella* in broiler and turkey flocks before slaughter, although the use of *Salmonella* testing results for risk management varies widely among MSs.

- Current *ante-mortem* and *post-mortem* visual inspection are not able to detect any of the public health hazards identified as the main concerns for food safety.

- *Ante-mortem* examination is carried out only on birds in a sample of crates, usually the most accessible ones, and the observation of individual birds in the crates is not easy. When *ante-mortem* examination is conducted on the farm, the risk of spreading infection within and between farms when the inspector visits several poultry houses in one day is increased.

- The high speed of the slaughter lines reduces the sensitivity of detection of lesions or carcass contamination by visual inspection. Thus, proper control cannot be achieved on all carcasses and only, at best, a sample of the birds can be thoroughly examined.

Conclusions CONTAM Panel

Ante- and *post-mortem* poultry inspection is different from *ante-* and *post-mortem* inspection of mammals. In the case of poultry, inspection is limited generally to visual inspection of external surfaces including eviscerated organs. The very short inspection time and the smaller size of poultry carcasses generally preclude the identification of suspect animals. In addition, for poultry the flock is the epidemiological unit and all FCI is provided at flock/farm level.

From the evaluation of the strengths and weaknesses of current meat inspection the CONTAM Panel concluded that

- The current procedures for sampling and testing are in general well-established and co-ordinated including follow-up mechanisms following identification of non-compliant samples.
- The system is well-endorsed by sector stakeholders and the regular sampling and testing for chemical residues and contaminants is a disincentive for the development of undesirable practices.
- The prescriptive sampling system allows for equivalence in the control of EU domestic poultry. Forthcoming measures have to ensure that the control of imports from Third Countries remains equivalent to the controls within the domestic market.
- A weakness is that chemical hazards are unlikely to be detected by traditional *ante-/post-mortem* meat inspection.
- The current NRCPs prescribe the number of samples that need to be taken but do not necessarily take into account information related to feed control. Integration between NRCP, feed control and environmental monitoring is currently limited.

Conclusions AHAW Panel

- The current poultry meat inspection system, both *ante-* and *post-mortem*, is valuable for maintaining a reliable food supply and for good animal welfare and disease management.
- In meat inspection of poultry, the epidemiological unit of interest is generally at the level of the flock or batch, rather than the individual animal, which influences the design and implementation of surveillance activities.
- Although some poultry diseases have been decreasing in frequency due to effective control methods, some have re-emerged due to new management or production systems, and new disorders or pathogens have also appeared. Meat inspection is often a key point for identifying outbreaks of existing or new disorders or disease syndromes.
- Animal-based welfare-outcome indicators have been developed for use on farm and at the abattoir for laying hens and for chickens and other poultry kept for meat production. These include hock-burn, foot-pad dermatitis, ascites, bruises, broken bones and deaths.
- In the course of normal commercial procedures, *ante-* and *post-mortem* inspection of poultry is an appropriate and practical way to evaluate the welfare of poultry on-farm, and the only way to evaluate the welfare of poultry during transport and associated handling. In relation to welfare during transport, *ante-mortem* inspection is important to detect mortality prior to slaughter and birds with major fractures.

- Currently, approximately 1-2% of poultry carcasses are condemned, predominantly due to endemic disease and welfare conditions, and are prevented from entering the human food chain. Few of these diseases and conditions can be identified during on-farm inspection.

- There are two key consequences of omission of visual *post-mortem* inspection on surveillance and monitoring for poultry health and welfare:

  – Current opportunities for data collection during visual *post-mortem* inspection will be lost, with the concomitant loss in information about the occurrence of existing or new disorders or disease syndromes of poultry in particular due to the loss of information from examination of condemned carcasses. Information on the occurrence of several important welfare problems will also be lost because many of those conditions can only be identified during post-mortem inspection at the abattoir.

  – There is the potential for carcasses with pathological changes, currently condemned and recorded during visual *post-mortem* inspection, to be further processed without the infectious nature of some conditions being detected. With respect to these carcasses, it is not known if the meat quality assurance system, as proposed, will achieve an equivalent sensitivity of detection as traditional visual meat inspection.

- In the absence of a system of visual *post-mortem* inspection, a process will be needed to ensure the removal of all abnormal carcasses with visible pathological changes or other abnormalities. Important information for disease management and for evaluation of welfare is obtained by the careful inspection of these carcasses by a qualified person.

- Extended use of FCI has the potential to compensate for some but not all of the information on animal health and welfare that would be lost if visual *post-mortem* inspection were removed. This can only occur if the FCI is designed to identify indicators for the occurrence of animal health and welfare disorders.

- FCI for public health purposes may not have an optimal design for surveillance and monitoring of animal health and welfare. Indeed, FCI directed to major zoonotic agents, such as *Salmonella* and *Campylobacter* which do not usually result in clinical disease in poultry, are likely to be of minor importance for surveillance and monitoring of animal health and welfare.

- FCI directed to identify indicators of animal health and welfare disorders with high risk of condemnation of carcasses at slaughter may have limited importance for public health. However, FCI may be used to determine additional inspection procedures for animals or group of animals to monitor specific animal health and welfare issues.

- As yet, only a limited number of studies have been conducted in Europe to evaluate the value of FCI in the context of surveillance and monitoring for poultry health and welfare.

- An additional system will be needed to compensate for a loss of surveillance and monitoring information following the removal of visual *post-mortem* inspection of all birds. It is proposed that this is achieved through detailed inspection of a defined subset of carcasses from each batch, guided by FCI and other epidemiological criteria, to obtain information for disease management and for evaluating animal welfare. The intensity (number of birds sampled) of targeted surveillance within each batch would be risk-based, with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch.

- If used optimally, FCI can be a valuable tool, and an economic incentive, to minimise the costs associated with the estimated 1-2% condemnation rate. A reduction in the condemnation

rate of poultry at slaughter will prevent associated flock health and welfare problems during production.

- Poultry health and welfare monitoring and surveillance system is reliant on a robust two-way information flow between farm and abattoir.

- The current feedback of relevant animal welfare and health data to farms of batches that were slaughtered can be used as broad measures of flock health and welfare.

- An extended use of FCI in the meat inspection process offers opportunities for an integrated use of animal-based welfare-outcome indicators, which the European Commission currently aim to use to check on the welfare of poultry and other farmed species, both on-farm and during transport. Their use will require data collection *ante-* and *post-mortem*, in some cases on all animals and in other cases on samples of animals.

- Systems of feedback from abattoir to farm are important, and can be further improved. More research and demonstration are needed on the integration of FCI for poultry surveillance and monitoring for welfare and disease management, including FCI that is most relevant for this purpose. Studies should investigate a range of outcomes, in addition to condemnation.

- Meat inspection, as currently practiced, is not equally effective in detecting different diseases/conditions of poultry.

- *Ante-mortem* inspection alone (if used correctly) has a relatively high probability of detecting most diseases and conditions in infected batches.

- The batch-level sensitivity is very dependent on the assumed within batch prevalence and the number of birds examined per batch. Batch-level detection probability increases with increased number of birds examined. An increase in sample size (that is, the number of birds sampled for more intensive meat inspection), as could occur with increased use of food chain information, will result in a higher batch-level sensitivity of meat inspection (for a given within batch prevalence) or the ability to detect lower levels of disease (at a given batch-level sensitivity).

- For epidemic poultry diseases/conditions, several different surveillance components are often available (for avian influenza, these include abattoir surveillance, clinical suspicion and serology). Based on model results (with underlying model input and assumptions), all three of these surveillance components are effective in detecting avian influenza in turkey broiler batches.

- Clinical surveillance of a flock (involving a large number of animals) is likely to be more sensitive and less costly than serological testing for early detection of epidemic diseases of poultry. In order to provide equivalent sensitivity, abattoir inspection would need to examine large numbers of individual birds per batch.

- The value of meat inspection as a surveillance method for endemic diseases and welfare conditions of poultry varies by disease/condition. Based on the model outputs, the estimated detection fraction was very high for septicaemia, IBD, high for ascites but very low for aspergillosis. However, these results need to be interpreted with care, given the underlying model assumptions.

- Based on the model outputs (with underlying model inputs and assumptions), either meat inspection or clinical suspicion could be used for surveillance of two of the four endemic poultry diseases/conditions. However, no effective surveillance alternative to meat inspection was available for either ascites or aspergillosis.

- The quantitative model provides insights into detection probabilities during meat inspection and the relative contribution of meat inspection in the overall surveillance system.

- The model outputs need to be interpreted with care, given uncertainty with respect to model inputs and assumptions. Further, the quantitative methodologies are more complex in poultry than other species, in large part due to the multi-hierarchical nature of modern poultry production (in effect, the multiple levels of interest, including countries, compartments, zones, farms, flocks, batches, birds). Model inputs were primarily reliant on expert opinion, as relevant published data are scarce. The modelled probability of detection is based on a range of assumptions, including the number of birds inspected per batch and an assumption of independence between each inspection step. The inclusion of the model in the approach, however, is maintained for consistency across all species for meat inspection systems.

- The conclusions from the qualitative and quantitative assessments are generally congruent, providing insights into the surveillance value of meat inspection as currently practised, and the implications on poultry health and welfare surveillance if proposed changes were introduced.

- The CONTAM conclusions and recommendations have limited impact on animal health and welfare surveillance and monitoring.

3. TOR 3. ***If new hazards currently not covered by the meat inspection system (e.g.* Salmonella, Campylobacter*) are identified under TOR 1, then recommend inspection methods fit for the purpose of meeting the overall objectives of meat inspection. When appropriate, food chain information should be taken into account.***

Conclusions BIOHAZ Panel

- None of the main public health hazards associated with poultry meat can be detected by traditional visual meat inspection. Other approaches are therefore necessary to identify and control these microbiological hazards, and this can be most readily achieved by improved FCI and interventions based on risk.

- An integrated food safety assurance system is outlined, including clear and measurable targets indicating what food business operators (FBOs) should achieve in respect to a particular hazard. These should be set as EU targets to be reached at the national level for prevalence and/or concentration of the hazards in poultry carcasses and, when appropriate, in poultry flocks before slaughter.

- Harmonised monitoring and targets are already in place for *Salmonella* in breeding flocks of *Gallus gallus*, and turkeys, flocks of laying hens producing table eggs, broiler flocks and fattening turkey flocks. This could be extended to other main hazards if effective intervention methods at the farm level can be applied or if the data obtained are useful for subsequent risk management.

- To meet these targets and criteria, a variety of control options for the main hazards are available, at both farm and abattoir level. A number of these measures have been described and assessed in earlier EFSA opinions.

- An important element of an integrated food safety assurance system is risk categorisation of poultry flocks based on the use of farm descriptors and historical data in addition to the flock-specific information, including the harmonised monitoring results. Farm-related data could be provided through farm audits using Harmonised Epidemiological Indicators (HEIs) to assess the risk and protective factors for the flocks related to the given hazards.

- An assessment of the historical data over a time period could also be used for adjusting the sampling frequency of the main hazards in order to focus control efforts where the risk is highest.

- A "risk history" for the holding to be recorded in the FCI could also facilitate future prospective logistic selection or remedial action, as it can be difficult for poultry companies in practice to correctly schedule slaughter or organise product placement based on the testing results from the actual flock sent for slaughter.

- Classification of abattoirs according to their capability to prevent or reduce faecal contamination of carcasses can be based on two elements: (1) the technologies applied including installed equipment and the hazard analysis and critical control points (HACCP) programmes in place; and (2) the process hygiene as measured by, for example, the level of indicator *E. coli* or *Enterobacteriaceae* on the carcasses (i.e. process hygiene criteria).

- The differentiation of abattoirs could provide a way of sending flocks presenting specific risk levels to adapted slaughter lines or abattoirs. For example, high-risk flocks might be directed to a specific category of abattoirs having suitable equipment and having demonstrated the ability to reduce the contamination of carcasses and to achieve an acceptable risk-reduction/contamination level in the final product.

- For abattoirs with an increased level of contamination, improvement of slaughter hygiene should be sought, for instance through technological developments.

- The performance of the abattoirs should be monitored, and a "risk history" of the abattoirs should be registered. Historical data could also form the basis for adjusting sampling frequency and sample sizes.

Conclusions CONTAM Panel

- Dioxins and DL-PCBs which accumulate in food-producing animals have been ranked as being of high potential concern. As these compounds have not yet been comprehensively covered by the sampling plans of the current meat inspection, they should be considered as "new" hazards.

- In addition, for a number of other organic contaminants that also may accumulate in food-producing animals very limited data regarding residues in poultry are available. This is the case, in particular, for (i) NDL-PCBs, (ii) brominated flame retardants, including PBDEs as well as HBCDDs.

- New technologies such as the production of bioethanol and biodiesel, and the increasing availability of new by-products used as animal feeds from these technical processes are issues of potential concern.

4. TOR 4. ***To recommend adaptations of inspection methods and/or frequencies of inspections that provide an equivalent level of protection within the scope of meat inspection or elsewhere in the production chain that may be used by risk managers in case they consider the current methods disproportionate to the risk, e.g. based on the ranking as an outcome of terms of reference 1 or on data obtained using harmonised epidemiological criteria. When appropriate, food chain information should be taken into account.***

Conclusions BIOHAZ Panel

- A wider, more systematic and better focused use of the FCI will have positive impact on control of the main public health hazards associated with poultry meat.

- *Ante-mortem* inspection of poultry does not directly contribute to the detection of the hazards identified as having public health relevance, but it can help to detect birds heavily contaminated with faeces and to assess the general health status of the flock. Taking this into consideration, no adaptations to the existing visual *ante-mortem* inspection are found to be required.

- Current *post-mortem* inspection methods do not directly contribute to preventing microbiological risks to public health, except by detecting heavily contaminated carcasses. The sensitivity of visual inspection to detect faecal contamination is considered to be low and there is not a direct association with the occurrence of pathogens. Therefore, it is proposed that the current visual inspection process is replaced by the establishment of targets for the main hazards on the carcass and by verification of the FBO's own hygiene management through the use of process hygiene criteria (PHC).

- Current *post-mortem* inspection does not increase the microbiological risk to public health unless the carcasses are handled as a consequence of the visual detection of abnormalities, leading to cross-contamination.

- Elimination of abnormalities on aesthetic/meat-quality grounds can be ensured through a meat quality assurance system and not through the official food safety assurance system including meat inspection. Any handling should be performed on a separate line and accompanied with laboratory testing as required.

Conclusions CONTAM Panel

- The contribution of visual clinical *ante-mortem* inspection of a flock and of *post-mortem* inspection of the carcasses is of limited value for the identification of chemical hazards. Therefore, control of undesirable or hazardous chemicals in poultry, in the context of current meat inspection, depends almost entirely on the samples taken and analyzed for residues and contaminants.

- Poultry farming in the EU is diverse (i.e. animal species, age, indoor, outdoor, integrated, conventional, organic farming) and hence the risk-profile for individual farms will vary.

RECOMMENDATIONS

1. **TOR 1.** ***To identify and rank the main risks for public health that should be addressed by meat inspection at EU level. General (e.g. sepsis, abscesses) and specific biological risks as well as chemical risks (e.g. residues of veterinary drugs and contaminants) should be considered. Differentiation may be made according to production systems and age of animals (e.g. breeding compared to fattening animals).***

Recommendations BIOHAZ Panel

- Poultry, particularly broilers, are recognised as a reservoir for ESBL-/AmpC-producing *E. coli*, but the occurrence in most EU MSs is not known. An EU-wide baseline survey for ESBL-/AmpC-producing *E. coli* to investigate the role of poultry meat as a source of human exposure is therefore recommended. Specific recommendations for the preferred methods for detection and characterisation of these resistant bacteria, as well as for harmonised monitoring of this resistance, were given in a recent EFSA Opinion.

- Because the hazard identification and ranking relates to the EU as a whole, refinements reflecting differences among regions or production systems are recommended if/where hazard monitoring data indicate.

- Furthermore, as new hazards might emerge and/or hazards that presently are not a priority might become more relevant over time or in some regions, both hazard identification and the risk ranking are to be revisited regularly to reflect this dynamic epidemiological situation.

- To provide a better evidence base for future risk ranking of hazards, initiatives should be instigated to:

  – improve data collection of incidence and severity of human diseases caused by relevant hazards;

  – systematically collect data for source attribution;

  – collect data to identify and risk rank emerging hazards that could be transmitted through handling, preparation and consumption of poultry meat.

Recommendation CONTAM Panel

- Regular updates of the ranking of chemical compounds in poultry presented in this document as well as of the sampling plans should take into account any new information regarding the toxicological profile of residues and contaminants, usage in poultry production, and actual occurrence of individual substances in poultry, with special emphasis on newly identified feed contaminants and environmental pollutants that may enter the food chain.

2. **TOR 2.** ***To assess the strengths and weaknesses of the current meat inspection methodology and recommend possible alternative methods (at* ante-mortem *or* post-mortem *inspection, or validated laboratory testing within the frame of traditional meat inspection or elsewhere in the production chain) at EU level, providing an equivalent achievement of overall objectives; the implications for animal health and animal welfare of any changes suggested in the light of public health risks to current inspection methods should be considered.***

Recommendations BIOHAZ Panel

- FCI provides a valuable tool for *Salmonella* risk management decision making. This can be extended to other hazards of public health relevance and thereby can be used for risk categorisation of flocks/batches. To achieve this, the system needs further development to include additional information important for food safety.

- Research on the optimal ways of using the collected FCI data for risk categorisation of poultry flocks/batches, as well as approaches for assessing the public health benefits (e.g. by means of source attribution methods) is required.

Recommendation CONTAM Panel

- Any new methods of meat inspection and related sampling and testing should include, in addition to the recognised strengths of the current system, consideration of animal husbandry and FCI, and better integration of feed control with chemical residues and contaminants monitoring.

Recommendations AHAW Panel

- If *post-mortem* inspection is changed, other approaches should be explored and applied to compensate for any associated loss of information on the occurrence of endemic diseases and other welfare conditions.

- Post-mortem checks should continue to be such that there can be removal from the slaughter line of each carcass unsuitable for human consumption due to visible pathological changes or other abnormalities. In order not to lose an important tool for information on animal health and welfare, qualified person should continue to examine those carcasses and a proportion should be subject to careful inspection in order to obtain information for disease management and for evaluating animal welfare.

- There should be specific *post-mortem* surveillance and monitoring for those welfare conditions that only can be identified during *post-mortem* inspection at the abattoir.

- The meat inspection framework should be adapted, as required, to changes in the epidemiological situation of current hazards and the emergence of new hazards. In cases of an epidemic disease alert, it should be possible to carry out a sufficiently detailed *post-mortem* inspection for targeted and risk based surveillance, including condemned birds.

- FCI should include information about both poultry health and welfare.

- An integrated system should be developed where FCI for public health and for animal health and welfare can be used in parallel.

- Research and demonstration should be conducted on the integration of FCI for poultry surveillance and monitoring for welfare and disease management. Studies should investigate the link between FCI for public health and for poultry health and welfare, and a range of outcomes, in addition to condemnation.

- Guidance should be provided on the application of targeted surveillance during meat inspection of poultry. The intensity (number of birds sampled) of targeted surveillance within each batch should be risk-based, with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch. The number of examined birds per batch should be justified and based on scientific data relating to the epidemiological situation, including within-batch prevalence, batch size, and bird-level detection sensitivity.

- It is recommended that epidemiological research is conducted to address data gaps relevant to the epidemiology of diseases/conditions of poultry in the EU, in particular those relating to flock and within-flock prevalence.

3. TOR 3. ***If new hazards currently not covered by the meat inspection system (e.g.* Salmonella, Campylobacter*) are identified under TOR 1, then recommend inspection methods fit for the purpose of meeting the overall objectives of meat inspection. When appropriate, food chain information should be taken into account.***

Recommendations BIOHAZ Panel

- Collection of baseline data and development of approaches for assessing abattoir process hygiene through the use of indicator *E. coli* or *Enterobacteriaceae* and the use of such results for risk categorisation of abattoirs is recommended.

- Appropriate methods for interpreting monitoring results of ESBL-/AmpC-producing *E. coli* and their association with antimicrobial usage should be developed.

- All parties involved in the proposed integrated food safety assurance system, including official veterinarians, official auxiliaries, abattoir staff and farmers, should be trained in the skills required for operating the new system.

Recommendation CONTAM Panel

- Control programmes for residues and contaminants should include new and emerging substances and should be regularly updated.

4. TOR 4. ***To recommend adaptations of inspection methods and/or frequencies of inspections that provide an equivalent level of protection within the scope of meat inspection or elsewhere in the production chain that may be used by risk managers in case they consider the current methods disproportionate to the risk, e.g. based on the ranking as an outcome of terms of reference 1 or on data obtained using harmonised epidemiological criteria. When appropriate, food chain information should be taken into account.***

Recommendations CONTAM Panel

- Sampling of poultry should be based on the available FCI.
- The frequency of sampling for farms should be adjusted to the appropriateness of the FCI presented.
- Analytical techniques covering multiple analytes should be encouraged and incorporated into feed quality control and national residue control plans.

APPENDIX A FROM THE PANEL ON BIOLOGICAL HAZARDS (BIOHAZ PANEL)

SUMMARY

Following a request from the European Commission, the Panel on Biological Hazards (BIOHAZ) and the Panel on Contaminants in the Food Chain (CONTAM) were asked to deliver a Scientific Opinion on the public health hazards (biological and chemical respectively) to be covered by inspection of meat for several animal species. This Opinion is the second of the series and deals with poultry. Briefly, the Panels were asked to identify and rank the main risks for public health that should be addressed by meat inspection, to assess the strengths and weaknesses of the current meat inspection methodology, to recommend inspection methods fit for the purpose of meeting the overall objectives of meat inspection for hazards currently not covered by the meat inspection system and to recommend adaptations of inspection methods and/or frequencies of inspections that provide an equivalent level of protection. The Panel on Animal Health and Welfare (AHAW) was asked to consider the implications for animal health and animal welfare of any changes proposed to current inspection methods for controlling public health risks.

The BIOHAZ Panel considered all poultry species together. Important differences between poultry species related to public health were highlighted when necessary. A decision tree was developed and used for risk ranking of poultry meat-borne hazards. The risk ranking was based on the magnitude of the human health impact; the severity of the disease in humans; the proportion of human cases that can be attributed to the handling, preparation and consumption of poultry meat; and the occurrence of the hazards in poultry flocks and carcasses. Based on this ranking, *Campylobacter* spp. and *Salmonella* spp. were considered to be of high public health relevance for poultry meat inspection. ESBL/AmpC gene-carrying bacteria were considered to be of medium to high (*E. coli*) and low to medium (*Salmonella*) public health relevance. For *C. difficile*, data for ranking were insufficient, but, based on the limited information available, the risk at the present time was considered to be low. The remaining hazards were considered to be of low public health relevance, based on available data, and were therefore not considered further.

The assessment of the strengths and weaknesses of the current meat inspection was focused on the public health risks that may occur through the handling, preparation and/or consumption of poultry meat. Considerations of the handling and preparation were restricted to activities carried out by consumers or professional food handlers immediately prior to consumption. Strengths identified were that Food Chain Information (FCI), as part of *ante-mortem* inspection, provides information related to disease occurrence during rearing and veterinary treatments, enabling a focused *ante-mortem* inspection on flocks with an animal health concern. *Ante-mortem* inspection can be used to verify FCI given by the farmer and to provide feedback to producers on problems detected, which are mainly issues not related to public health. In addition, visual inspection of live animals can detect birds heavily contaminated with faeces. Such birds increase the risk of cross-contaminating carcasses with hazards during slaughter and may consequently constitute a food safety risk that can be reduced if such birds/carcasses are dealt with adequately. Visual detection of faecal contamination of carcasses at *post-mortem* inspection can also be an indicator of slaughter hygiene, but other approaches to verify slaughter hygiene are considered more appropriate.

The following food safety-related weaknesses were identified: FCI lacks adequate and standardised indicators for the main public health hazards identified. Exceptions are the results of the harmonised monitoring of *Salmonella* in broiler and turkey flocks before slaughter. Current *ante-mortem* and *post-mortem* visual inspection are not able to detect any of the public health hazards identified as the main concerns for food safety. *Ante-mortem* examination is carried out only on birds in a sample of crates, usually the most accessible ones, and the observation of individual birds in the crates is difficult. The high speed of the slaughter lines reduces the sensitivity of detection of lesions or faecal carcass contamination by visual inspection *post-mortem*. Thus, proper control cannot be achieved on all carcasses and only, at best, a sample of the birds can be thoroughly examined.

As none of the main public health hazards associated with poultry meat can be detected by traditional visual meat inspection, other approaches are necessary to identify and control these microbiological hazards. This can most readily be achieved by improved FCI and interventions based on risk. An integrated food safety assurance system is therefore outlined, including clear and measurable targets indicating what food business operators (FBOs) should achieve in respect to a particular hazard. These should be set as EU targets to be reached at the national level for prevalence and/or concentration of the hazards in poultry carcasses and, when appropriate, in poultry flocks before slaughter. Harmonised monitoring and targets similar to those that are already in place for *Salmonella* could be extended to other main hazards if effective intervention methods at the farm level can be applied or if the data obtained are useful for subsequent risk management for instance scheduling of high risk poultry flocks/batches for slaughter.

To meet these targets, a variety of control options for the main hazards are available at both farm and abattoir level. An important element of an integrated food safety assurance system is risk categorisation of poultry flocks based on the use of farm descriptors and historical data in addition to the flock-specific information. Farm-related data could be provided through farm audits to assess the risk and protective factors for the flocks related to the given hazards. An assessment of the historical data over time could be used for adjusting the sampling frequency of the main hazards in order to focus control efforts where the risk is highest. A 'risk history' for the holding, recorded in the FCI, could also facilitate future prospective logistic selection or remedial action.

Classification of abattoirs according to their capability to prevent or reduce faecal contamination of carcasses can be based on the technologies applied, including installed equipment and the HACCP programmes in place, and/or on the process hygiene as measured by e.g. the level of indicator organisms such as *E. coli* or *Enterobacteriaceae* on the carcasses i.e. establishment of Process Hygiene Criteria (PHC). The differentiation of abattoirs could provide a way of sending flocks presenting specific risk levels to adapted slaughter lines or abattoirs. For abattoirs with an increased level of contamination, improvement of slaughter hygiene should be sought, for instance through technological developments. The performance of the abattoirs should be monitored and a "risk history" of the abattoirs registered. Historical data could form the basis for adjusting sampling frequency and sample sizes.

Finally, it was concluded that a wider, more systematic and better focused use of the FCI will have positive impact on control of the main public health hazards associated with poultry meat. *Ante-mortem* inspection of poultry can help to detect birds heavily contaminated with faeces and to assess the general health status of the flock, so no adaptations to the existing visual *ante-mortem* inspection are found to be required. As the sensitivity of current *post-mortem* visual inspection to detect faecal contamination is considered to be low, it is proposed that the current visual inspection process is replaced by the establishment of targets for the main hazards on the carcass and by verification of the FBO's own hygiene management through the use of PHC. On the other hand, current *post-mortem* inspection does not increase the microbiological risk to public health unless the carcasses are handled as a consequence of the visual detection of abnormalities, leading to cross-contamination. Elimination of abnormalities on aesthetic/meat-quality grounds can be ensured through a meat quality assurance system and should not be part of the official food safety assurance system including meat inspection.

A series of recommendations were made on data collection, interpretation of monitoring results, future evaluations of the meat inspection system and hazard identification/ranking, training of all parties involved in the poultry carcass safety assurance system, and needs for research on optimal ways to use FCI and approaches for assessing the public health benefits.

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ASSESSMENT

1. Introduction

1.1. Definition of meat inspection and scope of opinion

Assessing current meat inspection systems for poultry with the aim of introducing improvements requires a common understanding of the term "meat inspection". However, it seems that there is no precise, universally agreed definition of *meat inspection* as a whole. Related pieces of the current European Union (EU) legislation (Regulation (EC) No 854/2004) define inspection as "the examination of establishments, of animals and food, and the processing thereof, of food businesses, and their management and production systems, including documents, finished product testing and feeding practices, and of the origin and destination of production inputs and outputs, in order to verify compliance with the legal requirements in all cases". However, the term *meat inspection* is not described specifically; rather, there are references to elements of the inspection process for meat such as *ante-* and *post-mortem* inspections and food chain information. Also, Codex Alimentarius, in its Code of Hygienic Practice for Meat (CAC/RCP 58-2005), describes *ante-mortem* inspection as "any procedure or test conducted by a competent person on live animals for the purpose of judgement of safety and suitability and disposition" and *post-mortem* inspection as "any procedure or test conducted by a competent person on all relevant parts of slaughtered/killed animals for the purpose of judgement of safety and suitability and disposition"; however, a definition of *meat inspection* as a whole is not stated. Consequently, the current understanding of the term *meat inspection* is probably based more on its practical application, and somewhat intuitive, than on a specific, formal definition.

The BIOHAZ Panel, therefore, through discussions with the European Commission's representative, defined the main scope of this scientific opinion as identifying and ranking the most relevant poultry meat safety risks, assessing the strengths/weaknesses of the current meat inspection system, proposing alternative approaches for addressing current meat safety risks, and outlining a generic framework for inspection, prevention and control (including related methodology) for the prioritised hazards that are not (sufficiently) covered by the current system. Microbiological hazards representing only occupational health risks and/or whose detection is not required through visual meat inspection are not considered in this document.

As the EU Regulations do not include different inspection requirements for the different species, and because no or only limited data are available for "minor" poultry species, all poultry species are considered together. The general description of production and slaughter procedures focuses on the main species (broilers/hens and turkeys), but any important differences concerning other species were considered when necessary.

For the evaluation of current meat inspection practices in the EU and in order to evaluate any important differences between countries and/or regions as well as between poultry species, the BIOHAZ Panel was supported by the work of a contractor who prepared a report providing an "Overview on current practices of poultry slaughtering and poultry meat inspection".[12] The conclusions from this report are referred to when relevant.

Chemical hazards and associated poultry meat safety risks were considered by the CONTAM Panel in a separate part of this opinion (see Appendix B). Although highest priority is given to the public health aims of the improvements of the biological/chemical meat safety system, any implications for animal health and animal welfare of proposed changes were assessed by the AHAW Panel (see Appendix C). Furthermore, issues related to epidemiological indicators and associated sampling/testing methodologies for hazards dealt with in this opinion were addressed by the Biological Monitoring Unit in a separate document (EFSA, 2012).

[12] www.efsa.europa.eu/en/supporting/pub/298e.htm

2. Hazard Identification and risk ranking

2.1. Methodology

Hazard identification

A *hazard* is defined by the Codex Alimentarius Commission (CAC) as a "biological, chemical or physical agent or property of food with the potential to cause an adverse health effect". The first step in the hazard identification carried out in this assessment focused on identifying biological hazards occurring in poultry and/or poultry meat that can be transmitted to humans, in whom they may cause disease. Hazards were identified based on evidence found in peer-reviewed literature and textbooks, through reported data (e.g. EU summary reports on zoonoses), previous assessments and EFSA opinions, and the BIOHAZ Panel's and Working Group's expert knowledge.

From the overall "longlist" of identified hazards (see Annex A), the Panel excluded those hazards for which no causal relationship between human infections and the handling, preparation and consumption of poultry meat could be documented through targeted literature reviews. In addition, hazards not presently found in food-producing animals or wildlife in the EU were omitted for further assessment. The final shortlist of identified hazards to be included in the risk ranking process consists of hazards occurring in the EU and in which evidence could be found of foodborne transmission through the *handling, preparation and/or consumption* of poultry meat. In the context of this opinion, when referring to *handling and preparation* this should be interpreted as handling of poultry meat that occurs immediately prior to consumption, when these activities are carried out by consumers or professional food handlers.

Risk ranking

The Panel developed a decision tree that was used for risk ranking of the poultry meat-borne hazards (Figure 1). The first step in the decision tree aims to identify and exclude those hazards that are introduced and/or for which the risk for public health relates to growth that occurs during processing steps after carcass chilling. The reasons for excluding such hazards for further assessment were: (1) the scope and target of meat inspection are focused on the food safety risks of the final poultry carcass at the end of slaughter when the carcasses are chilled but before they are further processed; and (2) hazards introduced and/or for which the risk relates to growth during post-carcass chill processes are better controlled later in the food production chain through, for instance, hazard analysis and critical control point (HACCP) programmes.

The following steps in the decision tree aim to categorise the remaining hazards according to their risk of causing infections in humans following the handling, preparation and/or consumption of poultry meat. CAC defines *risk* as "a function of the probability of an adverse health effect and the severity of that effect, consequential to one or more hazards in a food". In other words, a foodborne risk is a product of the likelihood of the occurrence of the hazard and the magnitude and severity of the consequences of the illness it causes on human health. Based on this, the Panel identified the following criteria as important for determining the final risk category:

I Magnitude of the human health impact, as measured by the reported incidence (notification rate) or number of cases. Where data allowed, the estimated total number of cases was presented, i.e. adjusting for under-reporting.

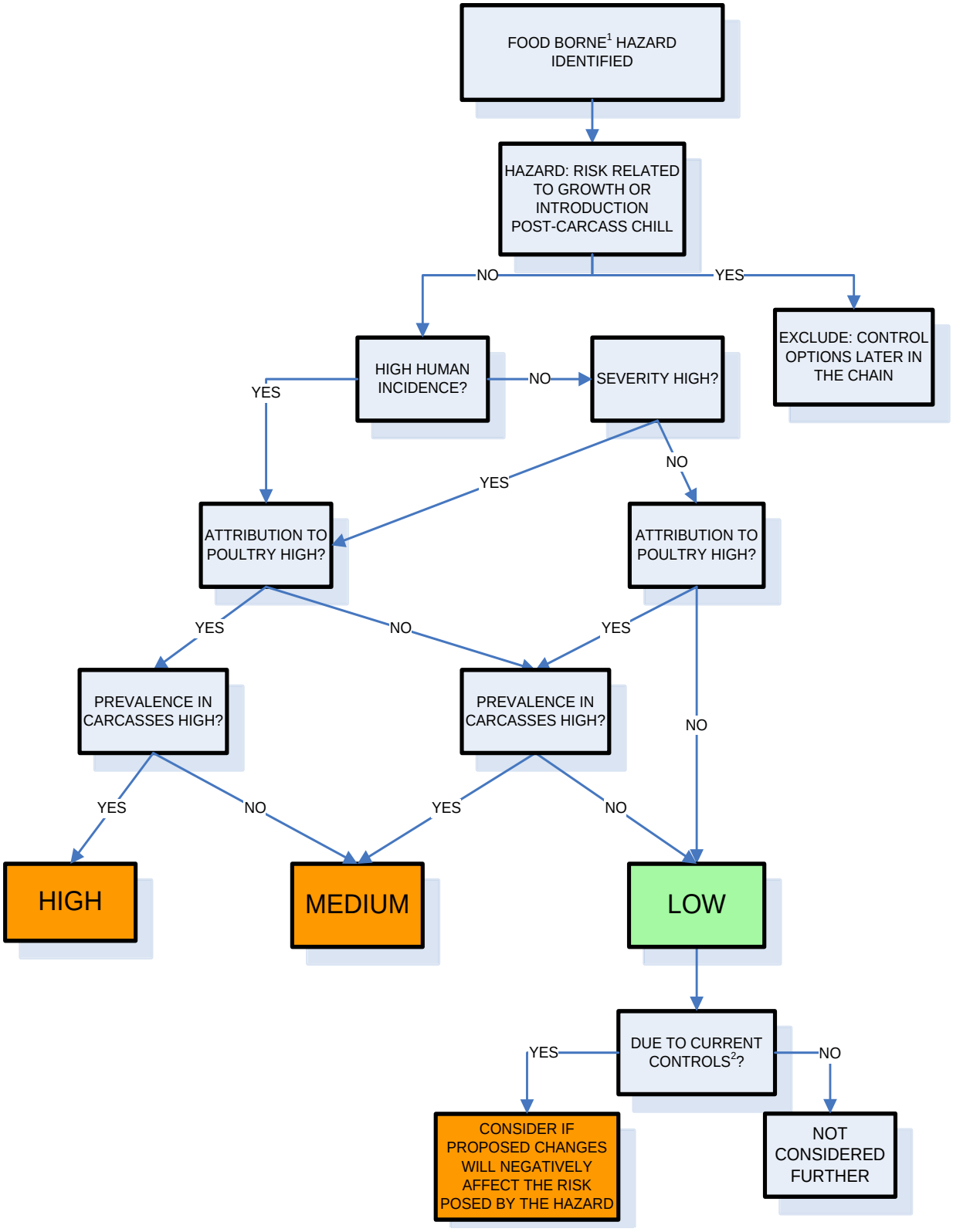
II The severity of the disease in humans based on mortality, hospitalisation, typically occurring symptoms, duration of illness and possible sequelae or long-term/chronic consequences. Where estimates were available, severity was also expressed in disability-adjusted life-years (DALYs) per 1 000 cases. The DALY metric quantifies the impact on health-related quality of life of acute diseases and sequelae (years lived with disability, YLDs), as well as the impact of premature deaths (years of life lost, YLLs).

III The proportion of the human cases that can be attributed to the handling, preparation and/or consumption of poultry meat. For some diseases, other major foodborne risks may exist, making poultry a minor source and consequently a relatively lesser risk.

IV The occurrence (prevalence) of the hazards identified in poultry flocks and/or poultry meat.

Data and information on these criteria were provided by ECDC and EFSA or retrieved or estimated from data published elsewhere. Based on the data, the hazards were divided into three risk categories: high, medium and low (Figure 1).

1) The high-risk category was defined as a hazard causing a high incidence and/or severity in humans and having **both** a high proportion of disease attributable to poultry **and** a high occurrence in poultry and/or poultry meat.
2) The medium-risk category was defined as a hazard causing a high incidence and/or severity in humans and having **either** a high proportion attributable to poultry **or** a high occurrence in poultry and/or poultry meat. **Alternatively**, it could be a hazard causing a low incidence and severity in humans but with **both** a high proportion attributable to poultry **and** a high occurrence in poultry and/or poultry meat.
3) The low-risk category was defined as a hazard causing a low human incidence but having high severity in humans and one in which both the proportion attributable to poultry and the occurrence in poultry and/or poultry meat are low. **Alternatively**, it could be hazard causing a low incidence and severity in humans and having **either** a low proportion attributable to poultry **or**, if the latter is high, having a low occurrence in poultry and/or poultry meat.
4) Some hazards may end up in the low-risk category due to existing control measures at farm and/or slaughterhouse level, which may have resulted in a low prevalence of the pathogen in some or all countries in the EU. Therefore, the low-risk category was, as a final step, divided into two categories, emphasising the need to assess the effect of proposed changes to the meat inspection system on the risk of such hazards. Hazards in the low-risk category for which no specific control is currently in place need not be considered further.



[1] Risk of infection through handling, preparation or consumption of poultry meat.
[2] Current controls: any hazard-specific control measures implemented at farm and/or slaughterhouse level before chilling of the carcasses.

Figure 1: Flowchart providing risk ranking of different hazards

2.2. Results

2.2.1. Hazard identification

A wide range of biological hazards was assessed as potentially able to be transmitted from poultry to humans (see Annex A). The majority of these were considered not to be poultry meat-borne pathogens as no evidence could be found in the literature to support transmission through handling, preparation or consumption of poultry meat. Other potential pathogenic microorganisms were found not to be relevant as they are not considered to be currently present in Europe (e.g. fish-borne zoonotic trematodes, such as *Centrocestus formosanus*, *Echinostoma cinetorchis* and *Hypoderaeum conoideum*). A final list of biological hazards assessed as transmissible to humans through the handling, preparation and/or consumption of poultry meat is presented in Table 1. The hazards were risk ranked using the decision tree (Figure 1).

Table 1: Foodborne biological hazards identified as transmissible to humans through the handling, preparation and/or consumption of poultry meat

Hazard	Type of poultry
Bacillus cereus toxins	Chickens, waterfowl[1]
Campylobacter spp. (thermophilic)	Chickens, turkeys, waterfowl
Clostridium botulinum toxin	Chickens, turkeys, waterfowl
Clostridium difficile	Chickens, turkeys
Clostridium perfringens toxin	Chickens, turkeys, waterfowl
Escherichia coli (toxicoinfectious strains including verocytotoxin-producing *E. coli*, VTEC)	Chickens, turkeys, waterfowl
Extended spectrum β-lactamase (ESBL)/AmpC (*E. coli*)	Chickens
ESBL/AmpC (*Salmonella*)	Chickens
Listeria monocytogenes	Chickens, turkeys, waterfowl
Salmonella spp. (non-typhoidal)	Chickens, turkeys, waterfowl
Staphylococcus aureus toxins	Chickens, turkeys, waterfowl
Yersinia enterocolitica	Chickens
Toxoplasma gondii	Chickens

[1]Including ducks and geese

2.2.2. Risk ranking of hazards according to decision tree

2.2.2.1. Hazards with risk related to growth or introduction post-carcass chill

L. monocytogenes and toxins of *B. cereus*, *C. botulinum*, *C. perfringens* and *S. aureus* were all considered to be hazards for which the public health risk is mainly controlled after post-carcass chill.

B. cereus, *C. botulinum*, *C. perfringens* and *S. aureus* are considered to be ubiquitous bacteria and can be found in a variety of foods as well as in the environment. Their vegetative forms need temperatures above those used for refrigeration to grow to levels of concentration of public health relevance, and thus the risk of disease seems not to be related with occurrence in raw meat but rather with improper hygiene and storage. Illness caused by *L. monocytogenes* is usually associated with ready-to-eat products (including products made of poultry meat), in which contamination has occurred before or during processing, followed by growth during prolonged storage at refrigeration temperatures.

These hazards were not considered further.

2.2.2.2. Hazards for further ranking

Data on incidence and severity of the disease in humans and prevalence in poultry carcasses were sought to allow the risk posed to be ranked, based on the decision tree in Figure 1 (see Tables 2 and 3 for details).

The data supplied by The European Surveillance System (TESSy) cover the years 2008, 2009 and 2010 and were aggregated at the EU level, without specifying particular countries. The data are considered reliable, albeit incomplete, as some countries did not report on certain diseases.

The data presented in Table 2 are related to notification rates and severity in humans. The notification rate is an adequate way of presenting the data because it takes into account only data "notified" to TESSy and includes as its denominator the overall EU population. Incidence rate would not be an accurate measure, as many cases are not accounted for by the health systems of the countries, e.g. people not visiting the doctor when they are ill, cases not fully diagnosed, etc.

Data on reported cases of *C. difficile* and ESBL/AmpC-carrying *E. coli* and ESBL/AmpC-carrying *Salmonella* were not available at the EU level.

Data on severity include the proportion of confirmed human cases that were hospitalised and the proportion of deaths, also among confirmed cases. These data only give an idea of the severity of the confirmed cases.

Severity was also evaluated by comparing the disease burden, expressed in DALYs per 1 000 cases, based on data reflecting the situation in the Netherlands, 2009 (Havelaar et al., 2012a). No data are available for *C. difficile* and *Y. enterocolitica*. However, acute yersiniosis is similar to acute salmonellosis and may lead to the same sequelae (reactive arthritis, irritable bowel syndrome). The case–fatality ratio of yersiniosis is similar to that of campylobacteriosis. Hence, the burden per case of yersiniosis is assumed to be in between the burden of campylobacteriosis and salmonellosis. These three bacterial infections cause a relatively low burden of 40–50 DALYs per 1 000 cases. The greater severity of diarrhoeal illness associated with *E. coli* O157, and in particular the impact of haemolytic uraemic syndrome as a sequela, is reflected in an approximately threefold higher burden per 1 000 cases. Clearly, the burden of toxoplasmosis (in particular congenital toxoplasmosis but also acquired toxoplasmosis) is 10- to 100-fold higher than the burden of the bacterial hazards. This is related to the impact of foetal and neonatal deaths, as well as the long-term impact of lesions in the eye (chorioretinitis).

Table 2: Overall human incidence and deaths and hospitalisations data reported by EU Member States as described in Decision (2119/98/EC) on communicable diseases and DALY estimates[1] (Havelaar et al., 2012a). Foodborne biological hazards of poultry origin identified to be transmissible to humans through consumption of poultry meat

Hazard	**Incidence in humans (reported confirmed cases per 100 000 EU population)**			**Severity in humans (reported confirmed hospitalisations/deaths among confirmed cases, %)**			**DALYs per 1 000 cases**
Year	2008	2009	2010	2008	2009	2010	
Campylobacter spp. (thermophilic)	38.5	39.9	44.4	N/A/0.01	4.36/0.01	2.40/0.12	41
C. difficile	N/A			N/A			N/A
E. coli (toxicoinfectious strains including VTEC)	0.6	0.73	0.73	N/A/0.06	4.1/0.16	9.9/0.21	143
ESBL/AmpC (*E. coli*)	N/A			N/A			N/A
ESBL/AmpC (*Salmonella*)	N/A			N/A			N/A
Salmonella spp. (non-typhoidal)	27.6	19.9	18.3	N/A/0.05	11.43/0.04	13.10/0.07	49
Y. enterocolitica	1.3	1.2	1.2	2.25/0.02	4.44/0.01	8.68/0	[40–50] assumed to be comparable to *Salmonella*
Toxoplasma gondii[2]	0.1	0.2	0.1	0/0.19	4.24/2.07	6.75/0	3 170/6 360 (acquired/perinatal)

N/A, not available.
1 From a single MS.
[2] Incidence and severity data related only to congenital toxoplasmosis.

Data presented in Table 3 are related to flock and carcass prevalence of the hazards identified in different poultry species (Anseriformes, chickens and turkeys). They were taken from the following data sources when available:

- Monitoring data as reported by the EU Member States (MSs) in the frame of the Zoonosis Directive (2003/99/EC). Data reported in the period from 2007 to 2010 were considered:
  - These data include results from the EU-wide harmonised monitoring of *Salmonella* in broiler and turkey flocks.
- Data collected through the 2008 EU-wide baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* in broiler carcasses.

Data on the occurrence of resistance to cefotaxime and ceftazidime in *Salmonella* and *E. coli* isolates recovered from poultry and meat thereof have also been taken from the EU monitoring data when available (EFSA and ECDC, 2012a). Such data can be used as an indicator of ESBL/AmpC resistance. As reports cover only phenotypic monitoring, it is not possible to determine the class or exact type of β-lactamase enzyme that is likely to confer the resistance detected to third-generation cephalosporins. MS-specific data reported on the occurrence of resistance to cefotaxime and ceftazidime in *Salmonella* and *E. coli* isolates from poultry and meat thereof are shown in Annex D. In addition, several MSs

have published results from national surveys and, although comparison of the results of these studies should be made with care owing to different sampling and laboratory methods, they give an indication of the level of ESBL-/AmpC-producing *E. coli* and *Salmonella*, particularly in broilers and broiler meat. These data are discussed in more detail under the hazard-specific paragraphs later in this chapter.

In the case of *C. difficile*, VTEC, *Y. enterocolitica* and *Toxoplasma* spp., flock and carcass prevalence data were either not reported or were reported from only a single MS. Data failing to indicate the poultry species from which the samples originated were excluded.

Table 3: Data on biological hazards of poultry origin that may be transmissible to humans through the handling, preparation and consumption of poultry meat. Data reported by EU Member States in the frame of the Zoonoses Directive (2003/99/EC)

Hazard	Data on flock prevalence			Data on prevalence in carcasses		
	Anseriformes	Broiler chicken	Turkey	Anseriformes	Broiler chicken	Turkey
Campylobacter spp. (thermophilic)	N/A[1]	71.2 % (95 % CI 68.5–73.7 %)[2]	N/A	N/A	75.8 % (95 % CI 73.2–78.3 %)[3]	61.2 %[4]
C. difficile	N/A	N/A	N/A	N/A	N/A	N/A
E. coli (toxicoinfectious strains including VTEC)	N/A	N/A	N/A	N/A	N/A	N/A
ESBL/AmpC (*E. coli*)	N/A	N/A	N/A	N/A	N/A	N/A
ESBL/AmpC (*Salmonella*)	N/A	N/A	N/A	N/A	N/A	N/A
Salmonella spp. (non-typhoidal)	27.1 %[5]	4.1 %[6]	12.1 %[7]	N/A	15.6 %[8]	10.7 %[9]
Y. enterocolitica	N/A	N/A	N/A	N/A	N/A	N/A
T. gondii	N/A	N/A	N/A	N/A	N/A	N/A

CI, confidence interval; NA, not available.

[1] Includes: no data reported, or data reported from only one MS and/or data only available without species being specified.

[2] EU prevalence of *Campylobacter*-contaminated broiler batches (and 95 % CI) from the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses in the EU in 2008 (EFSA, 2010a). *Campylobacter*-contaminated broiler batches were considered as an indicator of the flock-level prevalence in the flock of origin.

[3] EU prevalence of *Campylobacter*-contaminated broiler carcasses (and 95 % CI) from the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses in the EU in 2008 (EFSA, 2010).

[4] 2010 monitoring data on *Campylobacter* in turkey carcasses at slaughterhouse (EFSA and ECDC, 2012b). Note that only Germany and Hungary reported data on turkey carcasses at slaughterhouse in 2010.

[5] 2010 monitoring data on *Salmonella* in ducks and geese (EFSA and ECDC, 2012b). Data reported by Denmark, Germany and Sweden.

[6] 2010 data from official control programmes on *Salmonella* in broiler flocks (EFSA and ECDC, 2012b).

[7] 2010 data from official control programmes on *Salmonella* in turkey production flocks (EFSA and ECDC, 2012b).

[8] EU prevalence of *Salmonella*-contaminated broiler carcasses (and 95 % CI) from the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses in the EU in 2008 (EFSA, 2010).

[9] 2010 monitoring data on *Salmonella* in fresh turkey meat at slaughterhouse (EFSA and ECDC, 2012b).

In addition to the data on flock and carcass prevalence, and the occurrence and severity in humans, the results of studies describing the epidemiological links between the occurrence of relevant hazards in poultry and resulting infections in humans were summarised (Table 4). Some of the studies cited were particularly aimed at providing quantitative estimates for the proportion of human cases attributable to poultry, i.e. so-called source attribution studies (Pires et al., 2009). However, for a number of the identified hazards, quantitative source attribution estimates were not available. Therefore, expert elicitation studies or other relevant literature making more descriptive inferences about the role of poultry as a source of human infections were consulted. Based on this, the Panel made an overall appraisal for each of hazards included in the risk ranking (Table 4).

Table 4: Source attribution of human cases to consumption of poultry meat

Hazard	Proportion of cases caused by poultry meat (method of attribution)	References on source attribution	Panel judgement on attribution of human cases to poultry as a source	Other references
Campylobacter (thermophilic)	EU level: Broiler meat 20–30 % Broiler reservoir: 50–80 %	EFSA (2010d)	The attribution to broilers is considered high in the EU as well as in most MSs. Attribution data for other poultry species are lacking. Among turkeys, the reported carcass prevalence is also high, but as consumption of turkeys is considerably lower than consumption of broilers, the Panel assessed the attribution to turkeys to be relatively lower as well	
C. difficile	Unknown	–	It is found on poultry carcasses and on poultry meat, but no links to human disease have been described. Most human cases are associated with healthcare settings and not considered related to food intake. The attribution to poultry is therefore expected to be low	Keessen et al. (2011)
E. coli (toxicoinfectious strains including VTEC)	Unknown	–	The attribution to poultry is considered to be of low relevance. Poultry has not been identified as a major source of VTEC in Europe. Where these bacteria have been isolated from poultry species, these have not been associated with the seropathotypes associated with human disease	EFSA (2007b); Havelaar et al. (2008); Kalin et al. (2012)
ESBL/AmpC (*E. coli*)	Unknown	–	Potentially high in some countries but with a high level of uncertainty. Selection pressure applied by antimicrobial treatment Papers from Canada and the Netherlands showing temporal association or similar genes in poultry meat and humans, but a causal link has not been fully proven or quantified	Tangden et al. (2010); Tham et al. (2010); Dutil et al. (2010)
ESBL/AmpC (*Salmonella*)	Unknown	–	Like their sensitive counterparts, ESBL-/AmpC-producing *Salmonella* involved in human disease are mostly spread through foods. Attribution is therefore assessed to be linked to the prevalence of resistant clones among food-producing animals	See below for *Salmonella*

Hazard	Proportion of cases caused by poultry meat (method of attribution)	References on source attribution	Panel judgement on attribution of human cases to poultry as a source	Other references
Salmonella spp. (non-typhoidal)	EU-level: Broiler reservoir 2–4 % Turkey reservoir 4–5 % EU level: Broiler reservoir 5–18 % Turkey reservoir 1–5 % MS variation: Broiler reservoir 0.1–40.2 % Turkey reservoir 0.2–15.2 % Denmark: Duck reservoir: ~1 % (microbial subtyping approach used in all reference studies)	Vose et al. (2011)[13]; Pires et al. (2011)[14] Hald et al. (2012)[15] Pires et al. (2011)[14] Anonymous (2011a)	Large variation between MSs. High in several MSs. It should be noted that relative attributable proportions change when the overall burden changes. They should therefore be considered together, particularly when comparing relative proportions among MSs or among different years/periods	
Y. enterocolitica	Unknown	–	The attribution to poultry is considered to be of low relevance. Several studies, including phylogenetic studies, point to the pig reservoir as the main source of human infections	Fearnley et al. (2005); Stabler et al. (2011)
T. gondii	Unknown	–	The attribution to poultry is considered to be of low relevance. Poultry meat was not a significant risk factor in an EU multicentre study. Most meat is from animals raised indoors, and chicken meat is usually well cooked. Outdoor production and chicken meat preparations are increasing, however	Cook et al. (2000); Havelaar et al. (2008)

[13] Vose D, Koupeev T and Mintiens K, 2011. A Quantitative Microbiological Risk Assessment of *Salmonella* spp. in broiler (*Gallus gallus*) meat production. Question No EFSA-Q-2010-00888 and EFSA-Q-2011-00340. Published as an external scientific report on 21 July 2011http://www.efsa.europa.eu/en/supporting/pub/183e.htm

[14] Pires S, de Knegt L and Hald T, 2011. Estimation of the relative contribution of different food and animal sources to human *Salmonella* infections in the European Union. Question No EFSA-Q-2010-00685. Published as an external scientific report on 28 July 2011: http://www.efsa.europa.eu/en/supporting/pub/184e.htm

[15] Hald T, Pires S, and de Knegt L, 2012. Development of a *Salmonella* source-attribution model for evaluating targets in the turkey meat production. Published as an external scientific report on 13 April 2012. http://www.efsa.europa.eu/en/supporting/pub/259e.htm

2.2.2.3. Risk categorisation of hazards according to the decision tree

Table 5: Risk ranking of hazards according to the categorisation in Figure 1

Hazard	Notification rate in humans	Severity (% deaths)	Severity (DALYs)	Source attribution	Prevalence in carcasses	Risk category
Criterion	(High: ≥ 10/100 000)	High in more than one year≥ 0.1 %	High: ≥ 100 DALYs per 1 000 cases	See Table 4	High: ≥ 5 %	
Campylobacter spp. (including *C. jejuni*, *C. coli* and *C. lari*)	High	Low	Low	High	High	High
C. difficile	Not available	(Expert opinion) High	Not available	Unknown	Not available	Unknown, expected to be low – not considered further
E. coli (toxicoinfectious strains including VTEC)	Low	High	High	Low	Low	Low – not considered further
ESBL/AmpC (*E. coli*)	N/A	(Expert opinion based on hospitalisation rates) High	N/A	High	Not available at EU level	Medium to high
ESBL/AmpC (*Salmonella*)	N/A	(Expert opinion) Low	N/A	High	Not available at EU level (low proportion of resistant isolates using flock data; see Annex D)	Low to Medium
Salmonella spp. (non-typhoidal)	High	Low	Low	High[1]	High	High
Y. enterocolitica	Low	Low	Low	Low	Not available	Low – not considered further
T. gondii	Low	High	High	Low	Not available	Low – not considered further

[1] As shown in Table 4, the attribution estimates vary greatly between MSs, which is considered to be a reflection of the effectiveness of implemented control programmes including for how long the control efforts have been in place.

***Campylobacter* spp.**

Campylobacteriosis is the most frequently reported zoonotic illness in the EU, with a reported incidence of 44.4 confirmed cases per 100 000 in 2010 (Table 2), and it is estimated that there are nine million cases of illness annually in the EU-27 (EFSA, 2010d). The severity of human disease as measured by the mortality percentage and DALYs (including the impact of the sequelae Guillain–Barré syndrome, reactive arthritis, irritable bowel syndrome and inflammatory bowel disease) is also presented in Table 2.

The human data for *Campylobacter* provided by ECDC from TESSy, although based on a limited fraction of human isolates being subtyped, revealed differences in the proportion of isolates of the three *Campylobacter* species most commonly associated with human disease: *C. jejuni*, *C. coli* and *C. lari*. Out of 246 055 cases confirmed between 2008 and 2010, 230 108 (93 %) were attributed to *C. jejuni*, 14 615 (6 %) to *C. coli* and 1 332 (0.5 %) to *C. lari*. These data are based on a limited fraction of human isolates being subtyped.

In the baseline survey conducted in 2008 (EFSA, 2010a), the EU-weighted mean prevalence of *Campylobacter*-colonised broiler batches was 71 % before slaughter and 76 % after slaughter (Table 3). In 2010, only two EU MSs reported data on the occurrence of *Campylobacter* on turkey carcasses with prevalences of 68 % and 26 %, resulting in an overall prevalence of 61 %. *Campylobacter* also occur frequently in the intestinal tract of other poultry species, but no monitoring data were available (Humphrey et al., 2007).

Handling, preparation and consumption of broiler meat may account for 20 to 30 % of human cases of campylobacteriosis, whereas 50 to 80 % may be attributed to the chicken reservoir as a whole (Table 4). There is ample evidence that (thermophilic) *Campylobacter* spp. are a foodborne hazard related to poultry meat, in particular by cross-contamination from contaminated poultry (broiler) meat to ready-to-eat foods (EFSA, 2010d).

Like their sensitive counterparts, antimicrobial-resistant *Campylobacter* involved in human disease are mostly spread through foods, especially poultry meat. As stated in a previous EFSA opinion (2008c), 'a major source of human exposure to fluoroquinolone resistance via food appears to be poultry, whereas for cephalosporin resistance it is poultry, pork and beef that are important, these food production systems require particular attention to prevent spread of such resistance from these sources.' There are no indications that resistant strains behave differently in the food chain compared with their sensitive counterparts, hence there is no need to consider these strains separately in the context of meat inspection.

Based on the presented data, it is concluded that *Campylobacter* spp. are of high public health relevance with regard to poultry meat inspection.

Clostridium difficile

Data on zoonotic infections by *C. difficile* in humans are not currently available; the disease is typically associated with healthcare settings, with a moderately high case–fatality rate (Wenisch et al., 2011).

No data on the occurrence of *C. difficile* in poultry flocks or carcasses were available from the EU monitoring data (Table 3). *C. difficile* was isolated at low levels (9–18 %) from samples of retail chicken in Canada (Weese et al., 2010). All isolates were ribotype 078, known as a human pathogen and previously associated with food animals. The zoonotic potential is unknown. In the Netherlands, *C. difficile* was found in 8/500 (2 %) meat samples (1/16 (6 %) from lamb and 7/257 (3 %) from chicken). Only one chicken sample yielded a known human pathogenic ribotype (001) (de Boer et al., 2011). The risk of *C. difficile* on meat products in the Netherlands is currently considered negligible (Keessen et al., 2011). Research in Austria found *C. difficile* in 3/59 (5 %) of samples taken from

broilers at slaughter, but not in meat (Indra et al., 2009). A recent review (Keessen et al., 2011) concluded that "The possibility that interspecies transmission of *C. difficile* occurs can not be excluded or proven based on the studies that are described in this review."

Given the scarcity of data in both humans and animals, it is not currently possible to determine the role, if any, that poultry meat plays in the epidemiology of human infections with *C. difficile*, but based on the limited available evidence the BIOHAZ Panel concluded that the risk at the present time is low.

E. coli toxigenic strains including VTEC

Verocytotoxin (or Shiga toxin) (VT/ST)-producing *Escherichia coli* (VTEC) are characterised by the production of potent cytotoxins that inhibit protein synthesis within eukaryotic cells. VTEC infections constitute a major public health concern, because of the severe illnesses that they can cause, such as haemorrhagic colitis and the haemolytic–uraemic syndrome (HUS), especially among children and the elderly. The incidence of VTEC infections in humans is low compared with other bacterial zoonoses, but potentially high in terms of severity in a proportion of cases. A total of 4 000 confirmed verotoxigenic *E. coli* infections were reported in 2010, corresponding to a notification rate of 0.7 cases per 100 000 population (Table 2). Most of these cases were caused by the serogroup O157. The number of reported verotoxigenic *E. coli* human cases has been increasing in the EU since 2008 (EFSA and ECDC, 2012b). Despite the relatively low numbers of human cases, the high infectivity and seriousness of disease (including the sequelae haemolytic–uraemic syndrome and end-stage renal disease) justify the inclusion of this group of bacteria as important foodborne pathogens. For details on severity estimates, see Table 2.

In animals and food most verotoxigenic *E. coli*-positive findings are from cattle and bovine meat, but the bacteria are also detected in other animal species and foodstuffs (EFSA and ECDC, 2012b). However, only very few MSs report data on the occurrence of VTEC in poultry or poultry meat. From three large investigations of poultry in Germany (2 430 animals in 2010 and 2 034 animals in 2007) and Hungary (26 494 animals in 2010), only Hungary reported VTEC findings (at a level of 4 %) (EFSA and ECDC, 2012b). Hungary reported high levels of VTEC-positive samples in pheasants (26 %).

During the past four years, seven MSs reported finding VTEC in broiler meat, the prevalence of positive samples ranging from 0 % to 14 %. Two MSs reported positive samples in turkey meat (0 % and 5 %). In 2010, Bulgaria examined 1 915 samples of broiler meat with no positive VTEC findings. Among 26 samples of turkey meat in Germany, no positive samples were found. Spain examined 74 samples of broiler meat and found 11 % positive for VTEC, with VTEC O157 being detected in one of the positive samples.

In the scientific literature there are no published data on the prevalence of VTEC in poultry meat in Europe, and there are no published data identifying poultry meat as a source of human infection with VTEC. Where VTEC strains have been found in poultry species, these have not been associated with the seropathotypes associated with human disease (EFSA, 2007b; Kalin et al., 2012). The attribution to poultry is therefore considered to be low (Table 4).

Based on the data available and the discussions above, the BIOHAZ Panel assessed that VTEC falls within the low-risk category (Table 5).

ESBL/AmpC gene-carrying bacteria

The total burden of human infection of ESBL-producing bacteria is not entirely known, nor is the prevalence of human faecal carriage. The data on frequency of occurrence in invasive infections in humans in Europe come from the European Antibiotic Resistance Surveillance System (EARS-Net: www.ecdc.europa.eu/en/activities/surveillance/EARS-Net/Pages/index.aspx). Human cases of bloodstream infections and infections of cerebrospinal fluid due to these bacteria have been

increasingly reported from hospitals in Europe since the year 2000. Infections with such resistant organisms may be more difficult to treat, and there is some evidence of increased severity compared with non-resistant *E. coli* infections (Schultsz and Geerlings, 2012).

Available, and particularly comparable, data on the occurrence of ESBL-/AmpC-producing bacteria in poultry and poultry meat are limited. These data have been recently summarised (EFSA and ECDC, 2012a) and can be described according to their origin. First, there are the EU monitoring data on the occurrence of resistance to cefotaxime and ceftazidime in *Salmonella* and *E. coli* isolates (Annex D). These data represent the proportion of isolates that are resistant to at least one of these two antimicrobials, and have to be interpreted with caution as this does not necessarily reflect the prevalence of the bacteria producing these enzymes and because varying methodologies with very different sensitivity and statistical validity at the population level have been used in different studies. From the available monitoring data, the proportion of reported isolates that is resistant is highest for *E. coli* isolates found in broiler flocks (18 %) and *Salmonella* isolates in broiler meat (11 %).

Information on the occurrence of ESBL-/AmpC-producing bacteria can also be gathered from national antimicrobial resistance reports. For example, the Netherlands reported a moderate occurrence of cefotaxime resistance of 18 % among *Salmonella* isolates and of 15 % among *E. coli* isolates in raw poultry meat products (Anonymous, 2008). In Sweden, ESBL- and /or AmpC-producing *E. coli* were found in 34 % of samples from broilers (Anonymous, 2011c). In Denmark (Anonymous, 2010b), a study using enrichment with ceftriaxone found resistant *E. coli* isolates in 27 % of pools of five cloacal swabs (53/197) from broilers, in 50 % of isolates from imported poultry products, and in 9 % of isolates from Danish broiler meat. The use of selective enrichment revealed ESBL-/AmpC-producing *E. coli* in food-producing animals, which were not found by standard resistance monitoring of indicator *E. coli*. This highlights the importance of using sensitive methods (screening on selective agar preceded by selective enrichment in a broth) as recommended in a recent BIOHAZ ESBL opinion (EFSA, 2011b).

Finally, data can also be found in the scientific literature from studies targeted at detecting ESBL and/or AmpC-producing bacteria. The available information reinforces the impression that bacteria producing these enzymes are present in the poultry population in many EU countries, at levels ranging from low to very high for *E. coli* (100 % in poultry farms in the Netherlands, as reported by Dierikx et al. (2010)). A summary of findings in the scientific literature can be found in a previous EFSA opinion (EFSA, 2011b). More recent publications have provided similarly high estimates of prevalence, both in broilers (Wasyl et al., 2012) and at levels ranging from 80 % to up to 100 % in poultry meat in the Netherlands and Portugal (Cohen Stuart et al., 2012; Costa et al., 2010; Overdevest et al., 2011).

In summary, available data on the occurrence of ESBL/AmpC are limited in both humans and poultry (and poultry products) for most MSs, and comparison among MSs and studies is very difficult owing to the use of different methodologies, sampling strategies, etc. Based on available data, the occurrence appears to be moderate to high in poultry species in most MSs. Furthermore, in MSs in which targeted studies have been conducted, the results indicate an increase in occurrence over time as well as a higher occurrence when compared with results from the standard resistance monitoring as reported in the EU summary reports. It would, therefore, be valuable to conduct an EU-wide baseline survey of ESBL-/AmpC producing *E. coli* to investigate the role of poultry meat as a source for human exposure. Specific recommendations for the preferred methods for detection and characterisation of these resistant bacteria, as well as for harmonised monitoring of this resistance, were given in a recent EFSA opinion (EFSA, 2011b).

The potential contribution of food-producing animals and/or foods to public health risks by ESBL and/or AmpC-producing bacteria is related to the presence of plasmid-mediated ESBL genes, including CTX-M ESBLs, SHV and Tem ESBLs and AmpC beta-lactamase families of genes. In addition, ESBL/AmpC-producing organisms are also frequently co-, or multiresistant, exhibiting resistance to other antimicrobial classes such as fluoroquinolones, aminoglycosides and trimethoprim-sulphamethoxazole due to associated resistance mechanisms. These antimicrobials have been

frequently employed in animal husbandry for therapy and prophylaxis, but increasing resistance has lead to the more regular use of potent antimicrobials that are priority options for serious human infections.

Although there is no firm evidence at this time, various studies support the theory that transfer of ESBL and/or AmpC-producing organisms from food animal production to humans is likely to be taking place (Anonymous, 2011b; Lavilla et al., 2008). These include studies suggesting that *E. coli* isolates from poultry are genetically related to human pathogenic *E. coli*. In studies comparing genetic similarities of *E. coli* derived from humans and poultry, antimicrobial resistant *E. coli* isolates from both reservoirs were more frequently genetically-related than antimicrobial-susceptible isolates (Johnson et al., 2007a; Johnson et al., 2007b; Vincent et al., 2010). The possibility that some of these *E. coli* strains can be transferred from poultry to humans by occupational exposure on farms or in meat-processing establishments has also been demonstrated (Hammerum and Heuer, 2009; Johnson et al., 2012; van den Bogaard et al., 2001; Vieira et al., 2011). In a recent study from the Netherlands, the results are suggestive of transmission of ESBL genes, plasmids and clones from poultry to humans, most probably through the food chain (Leverstein-van Hall et al., 2011). From Canada, Dutil et al. (2010) reported on observed temporal links between the use of ceftiofur in chickens followed by the occurrence of resistant AmpC gene-carrying *S. enterica* subsp. *enterica* serovar Heidelberg and *E. coli* strains in chickens and humans. This occurrence of resistance decreased after reducing the use of this routine prophylactic medication and increased after it was re-introduced for economic reasons. Also, a recent EFSA opinion (2011b) indicated that transmission of ESBL genes, plasmids and clones from poultry to humans is most likely to have emerged following the routine use of ceftiofur mixed with Marek's disease vaccine injection or by spray in hatcheries for preventive treatment of day-old chicks.

In conclusion, it is difficult to precisely estimate the quantitative contribution of ESBL-/AmpC-carrying *E. coli* from poultry to human infections, largely relating to the different levels of monitoring, vastly differing sensitivities of different monitoring and testing options and lack of harmonised methods for determining resistance and assigning its genetic background (EFSA, 2011b). Nevertheless, accumulating evidence through specific studies in some countries has resulted in a medium- to high-risk categorization for this emerging hazard, based on expert opinion (Table 5).

***Salmonella* spp.**

Human salmonellosis is the second-ranking foodborne disease reported in EU and most European countries, exceeded only by campylobacteriosis (EFSA, 2008b; EFSA and ECDC, 2012b). A total of 99 020 confirmed cases were reported from 27 EU MSs in 2010 through TESSy, corresponding to a notification rate of 21.5 confirmed cases per 100 000 (Table 2, which also includes data on the severity of human disease, including the impact of the sequelae reactive arthritis, irritable bowel syndrome and inflammatory bowel disease). Accounting for under-reporting, it is estimated that there are six million cases of this illness annually in the EU-27 (EFSA, 2011c; Havelaar et al., 2012b).

Non-typhoid *Salmonella* serovars affect a wide range of animals and humans, and all are considered pathogenic for humans, but the degree of host adaptation varies, which affects the pathogenicity. There is a group of serovars that are highly adapted to an animal host, e.g. *S.* Cholerasuis in pigs, *S.* Dublin in cattle, *S.* Abortus-ovis in sheep and *S.* Gallinarum in poultry. These serovars only occasionally infect humans, in whom they may produce no, mild or serious disease (Acha and Szyfres, 2001; Mølbak et al., 2006). The non-host-adapted serovars are those with principal zoonotic significance, and the ability of these to infect animals and eventually infect humans via food seems to vary (Hald et al., 2007; Pires and Hald, 2010). *S.* Enteritidis and *S.* Typhimurium are the most frequently reported serovars in the EU and have been for many years, although the number of reported cases of *S.* Enteritidis has more than halved since 2006. In 2010, 45 % of all *Salmonella* infections were caused by *S.* Enteritidis and 22 % by *S.* Typhimurium (EFSA and ECDC, 2012b). A wide range of other serovars are also frequently reported as causes of disease in humans, although the reported number of human cases is generally considerably lower and their relative importance seems to fluctuate more frequently (EFSA and ECDC, 2012b; EFSA and ECDC, 2011; Vieira et al., 2008). This

indicates that besides *S.* Enteritidis and *S.* Typhimurium, serovars of public health significance (as defined by Regulation (EC) No 2160/2003) may vary over time and between countries reflecting the epidemiological situation in the country as well as in the EU.

According to the EU-wide *Salmonella* baseline studies conducted in broiler flocks in 2005/2006 and on broiler carcasses in 2008, the Community-observed prevalences were reported to be 24 % and 16 %, respectively (EFSA, 2007a, 2010a). Results from the harmonised monitoring in 2010 showed an EU flock prevalence average of 4 % (Table 3) and indicated that the flock prevalence has decreased in many MSs, although the effect of the differences in sampling and testing compared with the baseline surveys is unclear and significant underestimation of prevalence is suspected in many countries. In flocks of fattening turkeys, the EU-weighted mean prevalence from the baseline survey was reported to be 31 % (EFSA, 2008a). In 2010, the reported flock prevalence was 12 % (Table 3). No *Salmonella* baseline studies have been conducted in other poultry species, but ducks are known to be an important reservoir of zoonotic *Salmonella*, although some studies report that many of the *Salmonella* subtypes found commonly in ducks are only reported infrequently in humans (Anonymous, 2011a). In 2009, four MSs reported occurrence of *Salmonella* in flocks of ducks ranging from 4 % to 63 % (EFSA and ECDC, 2011), and in 2010 the average reported by three MSs was 27 % (Table 3).

Human infection is most often foodborne, and poultry meat and poultry products are common sources of both sporadic and outbreak-related cases of human salmonellosis[16]. A *Salmonella* source attribution study based on data from the EU-wide baseline surveys and the EU summary reports, as well as data provided by ECDC and EFSA, provided source attribution estimates for four animal reservoirs (pigs, broilers, layers and turkeys) for 24 MSs. Turkeys and broilers were estimated to be less important sources of *Salmonella* compared with laying hens and slaughter pigs, contributing 4 % (95 % confidence interval (CI) 3.8–4.3 %) and 3 % (95 % CI 3.1–3.7 %) of all human cases in the EU. However, the results also showed that the relative contribution varied between countries from 0.2 % to 15 % in turkeys and from 0.1 % to 40 % in broilers. This variation is likely to reflect differences in the efficiency of national surveillance and control efforts[10]. A very similar study providing virtually the same relative attribution estimates for the broiler and turkey reservoir was conducted by Vose in 2011[17]. Both studies also indicated that, although the majority of human cases attributed to broilers and turkeys were caused by *S.* Enteritidis and *S.* Typhimurium, other serovars, such as *S.* Infantis, *S.* Virchow, *S.* Kentucky, *S.* Newport, *S.* Saintpaul and *S.* Hadar, were also relatively important compared with the laying-hen and pig reservoir, from where human infections caused by *S.* Enteritidis and *S.* Typhimurium predominated (Pires et al., 2011[10]; Hald et al., 2012[18]).

Based on the data presented and the discussions above, it is concluded that *Salmonella* spp. are a high priority with regard to poultry meat inspection (Table 5).

The occurrence of antimicrobial resistance among zoonotic *Salmonella* is an increasing problem. Antimicrobial-resistant *Salmonella* involved in human disease are mostly spread through foods, predominantly poultry meat, eggs, pork and beef (Hald et al., 2007). As there are no indications that resistant strains behave differently from their sensitive counterparts in the food chain, there is no need to consider these strains separately in the context of meat inspection. Poultry meat is recognised as a major source of human exposure to particular fluoroquinolone-resistant *Salmonella* spp., but high levels of ESBL-/AmpC-producing *Salmonella* have also been reported in poultry in some EU MSs (EFSA and ECDC, 2012a) and these, along with fluoroquinolone-resistant strains, may or may not be

[16] Pires S, de Knegt L and Hald T, 2011. Estimation of the relative contribution of different food and animal sources to human *Salmonella* infections in the European Union. Question No EFSA-Q-2010-00685. Published as an external scientific report on 28 July 2011: http://www.efsa.europa.eu/en/supporting/pub/184e.htm

[17] Vose D, Koupeev T and Mintiens K, 2011. A Quantitative Microbiological Risk Assessment of *Salmonella* spp. in broiler (*Gallus gallus*) meat production. Question No EFSA-Q-2010-00888 and EFSA-Q-2011-00340. Published as an external scientific report on 21 July 2011http://www.efsa.europa.eu/en/supporting/pub/183e.htm

[18] Hald T, Pires S, and de Knegt L, 2012. Development of a *Salmonella* source-attribution model for evaluating targets in the turkey meat production. Published as an external scientific report on 13 April 2012. http://www.efsa.europa.eu/en/supporting/pub/259e.htm

associated with a significant level of human infection, depending on the pathogenicity of the strains involved and the opportunity for them to contaminate the food chain (Butaye et al., 2006; de Jong et al., 2012; EFSA, 2011b; Rodriguez et al., 2012). The control of antimicrobial-resistant bacteria in food including poultry meat is further complicated by the fact that resistance mechanisms can be located on mobile genetic elements such as plasmids and thereby be transferred between different bacterial species, for instance between generally apathogenic *E. coli* and *Salmonella* spp.

The use of antimicrobials in food-producing animals is a major contributing factor to the selection and dissemination of resistant *Salmonella* (Emborg et al., 2007; van den Bogaard and Stobberingh, 1999), but the increasing use of antimicrobials, particularly fluoroquinolones, in humans has also recently been shown to be associated with an increased incidence of infections caused by drug-resistant *Salmonella* (Koningstein et al., 2010). Compared with patients infected with susceptible *Salmonella* strains, patients with multidrug-resistant infections also seem more likely to have a protracted course of disease that, in addition to being more severe, often requires hospitalisation and may lead to excess mortality (Helms et al., 2003; Varma et al., 2005).

Available data on the occurrence of ESBL/AmpC *Salmonella* in humans and poultry are limited (Tables 2 and 3). Based on published studies on the potential public health consequences of being infected with a resistant *Salmonella* strain, as well as the apparent increasing prevalence of ESBL/AmpC *Salmonella* in poultry and poultry products in some countries, the overall risk is assessed to be low to medium (Table 5).

Yersinia enterocolitica

Symptoms of human yersiniosis are mostly those of gastroenteritis, with abdominal pain that may mimic appendicitis. Reactive arthritis is an infrequent but significant sequela of this infection (Butler, 1998). *Y. enterocolitica* was the third-ranking zoonotic bacterial infection reported in the EU in 2009 with a total of 7 595 confirmed cases and a notification rate of 1.2 per 100 000 (Table 2). The severity of human disease, as measured by the percentage mortality and the assumed DALYs, is presented in Table 2. In Europe, the majority of human pathogenic *Y. enterocolitica* belongs to biotype 4 (serotype O:3) or less commonly biotype 2 (serotype O:9, O:5,27) (EFSA and ECDC, 2011; Stabler et al., 2011).

Pigs are recognised as the dominant animal reservoir, but ruminants, horses, dogs and cats are also described as prominent hosts (Butler, 1998; McNally et al., 2004; Milnes et al., 2008). In contrast, domestic poultry species appear to be more accidental hosts with only a few findings reported in the literature (de Boer et al., 1983). Occurrence of *Y. enterocolitica* in poultry meat is described, but generally the recovered isolates are found to belong to apathogenic biogroups (Cox et al., 1990; Falcao et al., 2006; Mayrhofer et al., 2004; Stabler et al., 2011). No data on the occurrence of *Y. enterocolitica* in poultry flocks or carcasses were available from the EU monitoring data (Table 3). Like *Listeria*, *Y. enterocolitica* can grow at refrigeration temperatures, meaning that post-harvest contamination of processed poultry meat can constitute a risk for consumers.

Several microbiological surveys and epidemiological studies have pointed to pig meat as the predominant source of human foodborne infections (Boqvist et al., 2009; Huovinen et al., 2010; McNally et al., 2004; Nesbakken et al., 2003). This is supported by other studies of the phylogenic relationship between human pathogenic types and animal types (Fearnley et al., 2005; Stabler et al., 2011). None of these studies indicated poultry meat as a significant source of human infections. It was, therefore, concluded that the attribution of *Y. enterocolitica* infections to poultry meat is low (Table 4).

Based on the data presented and the discussions above, the BIOHAZ Panel assessed that *Y. enterocolitica* falls within the low-risk category and that the low risk is not caused by any current pathogen-specific control measures (Table 5).

Toxoplasma gondii

T. gondii infections in humans are prevalent in the EU and worldwide, as observed from seroprevalence studies (see, for example, Pappas et al. (2009)). Infections are less common (seroprevalence < 20 %) in northern Europe, most common in central Europe (seroprevalence 40–60 %) and at intermediate levels in southern Europe (seroprevalence 20–40 %). Nevertheless, clinical toxoplasmosis is rare, with the incidence of congenital toxoplasmosis in Europe being between 1 and 5 per 10 000 live births (Kortbeek et al., 2009; Roser et al., 2010; Villena et al., 2010) (see also Table 2). Acquired toxoplasmosis is increasingly seen as a cause of eye conditions (chorioretinitis; (Gilbert and Stanford, 2000)).

Owing to the lifelong impact of symptoms related to toxoplasmosis, the burden of disease is high (see Table 2 for data on mortality percentage and DALYs), and *T. gondii* ranks highest in population burden (DALY) among 14 foodborne pathogens from both an individual and a population perspective (Havelaar et al., 2012a).

No data on the occurrence of *T. gondii* in poultry flocks or carcasses were available from the EU monitoring data (Table 3). In a comprehensive study, the prevalence of *Toxoplasma* was determined in 2 094 meat samples each of pork, beef and chicken, obtained from 698 retail meat stores from 28 geographic areas of the USA. A pool of 6 samples, each weighting 100 g, were fed to *Toxoplasma*-free cats, and faeces were examined for oocyst shedding. Overall, the prevalence of viable *Toxoplasma* in retail pork was very low with a total of 10 isolates, whereas none of cats fed chicken or beef samples became positive (Dubey et al., 2005). A recent study demonstrated the presence of *T. gondii* DNA in the meat from seronegative cattle (Opsteegh et al., 2011). The infectiousness of such meat remains to be evaluated. Hence, there does not appear to be a correlation between serology and presence or absence of *T. gondii* in beef.

Studies on source attribution of human toxoplasmosis are lacking (Table 4). A recent review by Dubey (2010) concluded that the risk of ingestion of *T. gondii* cysts in meat from chickens from commercial indoor farms is low, but that a high prevalence of the parasite is found in backyard and free-range chickens. Edelhofer and Prossinger (2010) found 36 % of free-range chickens in Austria to be infected with *Toxoplasma*. In Brazil, consumption of chicken was a significant risk factor for *T. gondii* seroprevalence in pregnant women (Sroka et al., 2010). In a European case–control study (Cook et al., 2000), eating raw or undercooked beef, lamb or pork, but not chicken, were significant risk factors. Consumption of other meats (including venison, horse, rabbit, whale and game bird) was also associated with an increased risk (Kijlstra and Jongert, 2008).

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

2.3. Conclusions and recommendations

A decision tree was developed and used for risk ranking poultry meat-borne biological hazards. Hazards that are introduced and/or for which the risk to public health relates to growth that occurs during processing steps after carcass chilling were not considered. The risk ranking was based on the following criteria: (I) the magnitude of the human health impact; (II) the severity of the disease in humans; (III) the proportion of human cases that can be attributable to the handling, preparation and/or consumption of poultry meat; and (IV) the occurrence (prevalence) of the identified hazards in poultry flocks and carcasses. The risk ranking did not consider the different poultry species separately.

Based on the risk ranking, the hazards were classified as follows:

- *Campylobacter* spp. and *Salmonella* spp. were considered of high public health relevance for poultry meat inspection.

- ESBL/AmpC gene-carrying bacteria were considered to be of medium to high (*E. coli*) and low to medium (*Salmonella*) public health relevance.

- In the case of *C. difficile*, data for ranking were insufficient, but, based on the limited information available, the Panel assessed the risk at the present time to be low.

- The remaining identified hazards were considered of low public health relevance, based on available data. For the low-risk hazards, no hazard-specific control measures are currently implemented at the farm and/or slaughterhouse level. These hazards were therefore not considered further.

Poultry, particularly broilers, are recognised as a reservoir for ESBL-/AmpC-producing *E. coli*, but the occurrence in most EU MSs is not known. An EU-wide baseline survey for ESBL-/AmpC-producing *E. coli* to investigate the role of poultry meat as a source of human exposure is therefore recommended. Specific recommendations for the preferred methods for detection and characterisation of these resistant bacteria, as well as for harmonised monitoring of this resistance, were given in a recent EFSA Opinion.

Because the hazard identification and ranking relates to the EU as a whole, refinements reflecting differences among regions or production systems are recommended if/where hazard monitoring data indicate.

Furthermore, as new hazards might emerge and/or hazards that presently are not a priority might become more relevant over time or in some regions, both hazard identification and the risk ranking are to be revisited regularly to reflect this dynamic epidemiological situation.

To provide a better evidence base for future risk ranking of hazards, initiatives should be instigated to:

- improve data collection of incidence and severity of human diseases caused by relevant hazards;

- systematically collect data for source attribution;

- collect data to identify and risk rank emerging hazards that could be transmitted through handling, preparation and consumption of poultry meat.

3. Assessment of the strengths and weaknesses of the current meat inspection of poultry

3.1. Historical background

Historically, the primary focus of meat inspection was the protection of human health. Meat inspection was risk based when it was first established more than 100 years ago, because it targeted serious zoonotic infections of that time, such as *Mycobacterium bovis* in cattle causing tuberculosis (Von Ostertag, 1899) and *Brucella abortus*.

In the early 1900s the poultry industry in Europe was small and represented a secondary occupation for farmers who raised birds for personal consumption. As no zoonotic disease was known to be transmitted through consumption of poultry, meat inspection was not implemented in these species.

Specific meat inspection in poultry was first mentioned in the USA, with the voting in of the Poultry Products Inspection Act in 1957, which established a mandatory inspection of poultry and poultry products sold in interstate and foreign commerce. In Europe, extension of meat inspection to the poultry industry was implemented in 1971 (Council Directive 71/118/EEC). The current meat inspection procedures have been based on the same principles since this time, and they remain visual-only procedures. With the implementation of the Hygiene Package in 2004, meat inspection for all animal species should be based on risk analysis (Regulation (EC) No 882/2004). This has introduced an integrated approach to the meat inspection process ("from farm to fork") and allowed the development of a tool to help to achieve this: the food chain information (FCI) (Regulation (EC) No 853/2004).

Today, the official meat inspection of poultry consists of *ante* and *post-mortem* inspections and an assessment of the reported FCI. The FCI collected at the farm has to be sent to the slaughterhouse before the poultry flock arrives at the slaughterhouse, so that the information is available for risk management action if needed. The *ante-mortem* inspection consists of an examination of the birds, which can be carried out either on farm or at the slaughterhouse. Finally, the *post-mortem* inspection is conducted on carcasses at the slaughterhouse. Both *ante-* and *post-mortem* inspections are carried out as visual inspection with no routine handling of the birds. The actual procedures under which poultry meat inspection is conducted may significantly differ between MSs. A detailed overview of the state of the art of current meat inspection procedures in the EU was summarised recently in an external report, and readers are referred to this report for detailed information (see contractor's report[19]).

However, irrespective of the meat inspection procedures in place, it is well recognised that birds presented at slaughter can be carriers of zoonotic microorganisms or residues of veterinary drugs that cannot be detected during *ante-* and *post-mortem* inspections and that improvements in management of these hazards in the slaughter process may lead to significant public health benefits (Williams and Ebel, 2012). Below is an assessment of the strengths and weaknesses of current practices in meat inspection for the protection of public health.

3.2. Food chain information

3.2.1. Description

The main rationale behind the use of FCI is that poultry flocks intended for slaughter can be classified into food safety risk categories, so that slaughter procedures and/or decisions on fitness for consumption can be adapted to the health status and food safety risk presented by the flock/batch. FCI must be checked for completeness and content as part of *ante-mortem* inspection. FCI may be used to adapt *ante-* and/or *post-mortem* inspections, e.g. to plan the number of inspectors needed on the slaughter line or to reduce the speed of the slaughter line to allow for a more detailed *post-mortem* inspection (see contractor's report[19]). FCI may also be used to fix the order of slaughter of the poultry batches, i.e. logistic slaughter.

[19] www.efsa.europa.eu/en/supporting/pub/298e.htm

A risk-based classification of flocks/batches is possible, provided that appropriate and relevant food safety information from previous production stages is submitted before the arrival of the slaughter batch at the slaughterhouse, or at least before slaughter, depending on the risk management action required as a result of such classification. *Ante-mortem* findings can also contribute to this risk-based classification. FCI should be provided to the slaughterhouse at least 24 hours in advance of the arrival of the birds in order for the food business operator (FBO) to plan slaughterhouse activity accordingly.

FCI serves to augment the process of evaluating the health of the birds, and preventing sick or abnormal animals entering the slaughterhouse, by providing early data on probable disease conditions that may be present in the flock. This is based on either direct information related to the health status of the flock (mortality rate, occurrence of disease, veterinary treatments, specific laboratory testing) or indirectly (changes in water or feed consumption, average daily weight gain). FCI is recorded at the flock level, and its minimum content is described in Regulation (EC) No 853/2004. FCI related to primary production of poultry flocks is based on a farmer's declaration. Most MSs have made available to poultry farmers a standardised FCI declaration form.

Little information is available on the reliability of FCI in poultry production, but a French comparison of on-farm collected survey data for 404 chicken flocks selected at random and the corresponding information declared on the FCI form (Lupo, 2009) has shown that declaration of FCI by chicken farmers is reliable when the form is well adapted and designed. Thus, FCI declared by farmers may be suitable for decision support at the slaughterhouse for meat inspection purposes. Standardising the collection and interpretation of the primary production information at the slaughterhouse is also necessary to ensure effective use of FCI.

The FCI principle includes a flow of information from farm to slaughterhouse in order to help classify the flock according to its expected food safety risk. Regulation (EC) No 853/2004 also requires feedback of the results of the meat inspection process from the slaughterhouse to farmers, but currently this feedback is not fully implemented in all MSs. However, the assessment of strengths and weaknesses will not consider the lack of compliance with current legislative requirements.

3.2.2. Strengths

FCI is currently being used as part of *ante-mortem* inspection and provides useful information. In particular, information related to disease occurrence during rearing and veterinary treatments helps to focus the *ante-mortem* inspection on flocks with an animal health concern.

Providing information related to *Salmonella* on-farm testing status within 3 weeks of slaughter is mandatory for broilers (Regulation (EC) No 646/2007) and turkeys (Regulation (EC) No 584/2008). Specific slaughter procedures, such as logistic slaughter or diversion to production of heat-treated products, can be decided according to this information. An example of actions implemented according to the *Salmonella* on-farm testing status of the poultry flock can be found in Annex B.

3.2.3. Weaknesses

Although the content of FCI is described in Regulation (EC) No 853/2004, it is not fully detailed. The legislation prescribes that each MS should define appropriate data that might be useful to ascertain the sanitary status of a flock, based on its own epidemiological disease context and farm organisation. As a consequence, each MS has implemented FCI in different ways (Table 6), and comparison among MSs is not straightforward.

Table 6: Examples of FCI items taken into account in the primary production of poultry[20]

Regulatory content of FCI (Regulation (EC) No 853/2004, Annex II, Section III, 3)	Common items among Member States	Different items among Member States
(a) The status of the holding of provenance or the regional animal health status	NS	NS
(b) The animals' health status	NS	FR: any pathological event encountered during the last 30 days of the rearing period with observed symptoms UK: any diagnosed disease, cause of high mortality other than disease
(c) Veterinary medicinal products or other treatments administered to the animals within a relevant period and with a withdrawal period greater than zero, together with their dates of administration and withdrawal periods	NS	DK: veterinary treatments FR: description of the treatment administered for the last 30 days (trade name or active compound, dosages, date of beginning and end, withdrawal time and identification number of the veterinary prescription, use of medical feedstuff) GE: description of the treatment administered for the whole production period in chicken and ducks and for the last 28 days in turkeys IT: use of medical feedstuffs, vaccination, therapy during the last 90 days (trade name or active compound, dates of administration and withdrawal periods) UK: description of the veterinary products or other treatments administered (trade name or active compound, dates of administration and withdrawal periods)
(d) The occurrence of diseases that may affect the safety of meat	NS	NS
(e) The results, if they are relevant to the protection of public health, of any analysis carried out on samples taken from the animals or other samples taken to diagnose diseases that may affect the safety of meat, including samples taken in the framework of the monitoring and control of zoonoses and residues	*Salmonella* on-farm testing, serotype of the *Salmonella* if positive result	DK, IT: *Campylobacter* testing FR: results of *Salmonella* laboratory tests (date of sampling, name of laboratory)
(f) Relevant reports about previous *ante-* and *post-mortem* inspections of animals from the same holding of provenance, including, in particular, reports from the official veterinarian	NS	FR, UK: meat inspection results available if previous flocks slaughtered in the same slaughterhouse IT: date of the last official control

[20] European Commision, Working group on hygiene measures, 2008. Inventory of the Reports on Food Chain Information sent by MSs. 35 pp.

Regulatory content of FCI (Regulation (EC) No 853/2004, Annex II, Section III, 3)	Common items among Member States	Different items among Member States
(g) Production data, when these might indicate the presence of disease	Total mortality rate	DK: stocking density, welfare data FR: production type, genetic strain, hatchery details, date of placement, number of animals at placement, flock size, average live weight at slaughter date, average live weight 1 and 2 weeks before slaughter date, cumulative mortality rate 1 and 2 weeks before slaughter date, characteristics of the feed, dates of distribution and withdrawal times IT: average weight, housing date UK: production type, hybrid or breed (for broilers only), age, flock size, mortality rate at 14 days
(h) The name and address of the private veterinarian normally attending the holding of provenance	IT, FR, UK, GE	NS

NS, not specified. DK: Denmark; FR: France; GE: Germany; IT: Italy; UK: United Kingdom

The food safety relevance of all the FCI items identified per MS is often limited. In addition, the reported information is based on common sense rather than on truly scientific criteria and its interpretation is not defined by legislation. Thus, the provision and use of FCI is not always consistent among MSs or even among producers and slaughterhouses in the same MS. Currently, the main factor taken into account when considering FCI-based risk categorisation of broiler flocks is the *Salmonella* on-farm testing status within 3 weeks of slaughter (Table 6). However, the results of this laboratory testing lead to different decisions among the MSs. For example, in the case of positive status some countries do not accept the poultry flock for slaughter, whereas others require logistic slaughter followed by intensive cleaning and disinfection of the line after slaughter of the flock. Heat treatment of products originating from the flock is further required by some MSs if *S.* Enteritidis or *S.* Typhimurium are detected. Further details can be found in the external report (see contractor's report[19]). In practice, FCI lacks adequate and standardised indicators for the main public health hazards previously identified, which could form the basis for risk categorising the flocks. Exceptions are the results of the harmonised monitoring of *Salmonella* in broiler and turkey flocks before slaughter (point (e), Table 6).

FCI can be used by slaughterhouses to plan the slaughter of flocks for commercial and operational reasons, e.g. with respect to certification requirements of products with special quality attributes. These are often related to outdoor access production (e.g. organic status) and, to be certified, the flock must be slaughtered at the beginning of the slaughter day, before any conventional poultry flocks. But, for example, the flocks that are likely to be positive for *Campylobacter* are mainly those with outdoor access intended for certification (Engvall, 2001; Heuer et al., 2001; Newell et al., 2011; Newell and Fearnley, 2003).

3.3. *Ante-mortem* inspection

3.3.1. Description

The *ante-mortem* examination is carried out to evaluate the health status of the birds and to help prevent sick or abnormal animals entering the slaughterhouse. This is a visual-only inspection, consisting of the identification of clinical signs or symptoms of disease. It is performed on a flock/batch basis. If there is exceptionally high mortality, a sample of the birds that are dead on arrival may be examined in further detail.

According to Regulation (EC) No 854/2004, *ante-mortem* inspection can be performed either at the slaughterhouse or at the farm. In practice, most MSs conduct *ante-mortem* inspection at the slaughterhouse (see contractor's report). In some countries *ante-mortem* inspection is performed on farm when the flock is expected to present a higher risk of animal health- and welfare-related conditions, such as obvious or specific *post-mortem* findings (e.g. foot pad dermatitis) or when there has been a repeated high condemnation rate in previous flocks. When conducted on farm, *ante-mortem* examination helps to give a better overview of the birds than when it is conducted at the slaughterhouse.

3.3.2. Strengths

Ante-mortem examination is mainly useful for detecting animal health and welfare concerns. It contributes to the evaluation of the health status of the flock and its transport conditions.

For public health concerns, *ante-mortem* examination can detect birds heavily contaminated with faeces, which may cause excessive contamination of the processing equipment (e.g. scalding tank and pluckers) and so contribute to cross-contamination of carcasses from the batch and subsequent batches processed until the slaughter line is cleaned and disinfected. Ensuring through current *ante-mortem* inspection that only visually clean poultry enter the routine slaughtering process helps to prevent cross-contamination, because microbial loads on feathers are reduced. Detection of flocks that are highly contaminated can be used for risk management action, e.g. logistic slaughter, cleaning down the line before subsequent flocks/batches enter and/or diverting carcases to non-fresh product or permitted carcass treatments.

Ante-mortem inspection can also be used to verify FCI given by the farmer and to provide feedback to producers on problems detected, usually for issues not related to public health. In particular, when *ante-mortem* inspection is conducted on farm, flock identification and aspects of FCI such as veterinary treatments can be verified.

3.3.3. Weaknesses

From a public health perspective, *ante-mortem* examination of poultry is of limited value, as birds infected with or carrying the main hazards previously identified very seldom show symptoms.

During lairaging at the reception platform of the slaughterhouse, birds are kept in transport crates that are stacked, generally separated in space by flock to ensure traceability, and arranged in rows. As a result, *ante-mortem* examination is carried out only on a sample of crates, usually the most accessible ones, and the observation of individual birds is not easy. In addition, even if birds are inspected individually after shackling on the slaughter line before stunning, light intensity is often reduced for welfare reasons and shackled birds do not show normal behaviour, which restricts the potential for clinical observation.

When conducted on farm, *ante-mortem* inspection can increase the risk of spreading infection within and among farms when the inspector visits several farms on one day.

3.4. *Post-mortem* inspection

3.4.1. Description

The *post-mortem* inspection of carcasses is designed to detect and withdraw from the food chain any carcass that has grossly identifiable abnormalities that could affect the meat safety or wholesomeness. These carcasses, rejected as unfit for human consumption, are detected on the basis of visual macroscopic criteria. The meat inspector examines external and internal surfaces of the carcasses and internal organs after evisceration for disease conditions and contamination that could make all or part of the carcass unfit for human consumption. *Post-mortem* meat inspection is conducted at an individual bird level. The outcome is qualified by reporting the descriptive findings and is quantified by the condemnation rate for the batch. In the EU, within-batch condemnation rates are very low,

often under 2 %, and result from a wide range of conditions (see Annex C, Tables C1 and C2, and contractor's report[19]).

Reasons for condemnation correspond more to anatomopathological findings than to a diagnosis of a cause leading to the observed lesions at the *post-mortem* inspection (Fallavena et al., 2000). For example, liver lesions can be related to subclinical necrotic enteritis in chickens, without being specific (Lovland and Kaldhusdal, 1999). *Post-mortem* inspection can also detect conditions such as acute septicaemia (without any possibility of differentiating the organisms causing this symptom) when there is an abnormal colour of carcass and offal (Fisher et al., 1998). Judgement of the fitness of meat for human consumption in current *post-mortem* inspection is based on the identification of conditions making meat unfit for human consumption. Despite efforts by MSs to standardise *post-mortem* inspection, such as organising specific training of meat inspectors or providing official definitions of the reasons for condemnation, the detection of lesions remains partially subjective and open to human interpretation. Studies of the reproducibility of visual meat inspection in poultry have shown moderate to good agreement between inspectors (Bisaillon et al., 1988) and 77 % of identical classification of the carcasses (Fries and Kobe, 1993). Agreement seemed to differ according to the reason for condemnation, reflecting personal judgement. Positive predictive value has been calculated to quantify the number of carcasses withdrawn from the food chain by meat inspectors that actually presented official reasons or conditions for condemnation. This indicator ranged from 57 % (Fries and Kobe, 1993) to 60–70 % (Bisaillon et al., 1988), demonstrating the limited and imperfect ability of visual poultry meat inspection to detect all carcasses that present reasons for condemnation.

Pathological findings may occasionally be associated with the presence of some public health hazards previously identified: spotty liver, which may in some cases be caused by focal aggregation of *Campylobacter* organisms in liver tissue and the consequent inflammatory response (Jennings et al., 2011; Shane and Stern, 2003), enlargement and small necrotic areas in the spleen and liver and *S. enterica* in chickens (Christensen et al., 1996), arthritis and *S.* Typhimurium in ducks (Bisgaard, 1981) (see also contractor's report[19]). Such problems may, however, be difficult to detect and quantify accurately because of the high speed of the poultry slaughter line, which results in a time of around 1 second per bird for inspection of the carcass and associated viscera.

Post-mortem inspection can take place at three stages: immediately after defeathering, immediately after evisceration (with the viscera presented separately or attached to the carcass), or on eviscerated carcasses, to check for slaughter defects, residues of feathers, faecal contamination, etc. The carcasses can pass one, two or three possible inspection stations during the slaughtering process, but in any case both carcasses and organs have to be inspected.

Developments in slaughter technology have mainly concerned the automation of the whole slaughter process. The increased degree of automation has led to an increase of slaughter line speeds (see contractor's report[19] for details on line speed per species). The faster lines are observed in chicken (up to 13 000 broilers per hour) and are almost twice as fast as in ducks (2 000 to 6 000 ducks per hour). As *post-mortem* inspection is only visual and the human eye has limited detection capacity, some MSs have set criteria to achieve a "proper" inspection as required by Regulation (EC) No 854/2004. For example, some countries insist on a minimum inspection time per carcass (e.g. 2.5 seconds). Under such high speeds, more or less sophisticated supplementary inspection technologies have been developed. A mirror is often placed opposite the inspector, so that he or she can view both sides of the carcass. Line dividers allow a longer inspection time per carcass by splitting and dividing the line at the inspection station, so only half the number of carcasses pass the inspectors. Automated inspection systems, consisting of cameras linked to analysing software, have also been developed to support inspectors' work. This ranges from detecting defects on carcass (Hoof and Ectors, 2001) or offal to screening for visible indicators of faecal contamination (Cho et al., 2009; Park et al., 2005).

3.4.2. Strengths

Post-mortem inspection enables to a certain extent detection of lesions related to animal health and welfare. For food safety concerns, *post-mortem* examination can detect visibly contaminated carcasses and offal, which might present an increased food safety risk if pathogens are present in the faeces, and is an indication of a hygienically inefficient slaughter process. Camera systems can help to identify the contaminated carcasses with greater reliability than the human eye. This is a strength if, once identified, these carcasses are dealt with adequately, i.e. not washed, and removed from the chain, contaminated skin trimmed (notably for ducks and turkeys), or not sold as fresh products.

3.4.3. Weaknesses

The main public health hazards previously identified rarely cause visible macroscopic lesions on carcasses or offal. Moreover, even lesions that may be suggestive of relevant pathogens are non-specific; therefore visual *post-mortem* inspection is of no value for controlling food safety concerns. The detection of lesions or other carcass abnormalities is mostly related to meat quality or animal health and welfare issues (see Annex C). A classification of 143 grossly detectable abnormalities and conditions encountered in poultry was previously proposed with respect to their risk for consumers (Bisaillon et al., 2001). However, that study concluded that, even if 25 % of these grossly detectable abnormalities and conditions might be potentially a concern from a food safety perspective, this assessment would need further characterisation and analysis. A formal risk assessment of lesions in poultry meat inspection is thus still lacking.

In addition, the high speed of the slaughter lines reduces the sensitivity of detection of lesions. Thus, proper control cannot be achieved for all carcasses and, at best, only a sample of the birds can be thoroughly examined. Moreover, abnormalities with a low prevalence are more often missed than abnormalities with a high prevalence. Thus, the very low condemnation rates reported (Annex C, Table C1, and contractor's report) result in a low positive predictive value for the current *post-mortem* inspection. Automated camera systems can enhance the detection of abnormalities, but, as each type of camera can detect only a specific type of lesion, a combination of several systems are required to fully automate the visual *post-mortem* inspection of poultry. Such systems need space and may not be easily implemented along the slaughter line. Moreover, this automated visual inspection system is applicable only to very homogeneous poultry processing systems, such as that of broiler chickens or turkeys.

The detection of visible faecal contamination alone is not a reliable indicator of increased risk to public health, as carcasses not visibly contaminated with faeces can still carry foodborne pathogens (Jimenez et al., 2002).

3.5. Conclusions and recommendations

The main elements of the current poultry meat inspection are analysis FCI, *ante-mortem* examination of animals, and *post-mortem* examination of carcasses and organs. The assessment of the strengths and weaknesses of the current meat inspection was focused on the public health risks that may occur through the handling, preparation and/or consumption of poultry meat.

Currently in the EU, the use of FCI for food safety purposes is limited except for *Salmonella* control, where it provides a valuable tool for risk management decision making. This can be extended to other hazards of public health relevance and thereby be used for risk categorisation of flocks/batches. To achieve this, the system needs further development to include additional information important for food safety, including definition of appropriate and standardised indicators for the main public health hazards.

FCI is being used as part of *ante-mortem* inspection and provides useful information. In particular, information related to veterinary treatments and disease occurrence during rearing helps focus the *ante-mortem* inspection on flocks with an animal health concern.

In practice, FCI lacks adequate and standardised indicators for the main public health hazards identified. Exceptions are the results of the harmonised monitoring of *Salmonella* in broiler and turkey flocks before slaughter, although the use of the *Salmonella* testing results for risk management (e.g. risk differentiation) varies widely among MSs.

Research into the optimal ways of using the collected FCI data for risk categorisation of poultry flocks/batches, as well as approaches for assessing the public health benefits (e.g. source attribution methods), is required.

Ante-mortem inspection can be used to verify FCI given by the farmer and to provide feedback to producers on problems detected, but usually for issues not related to public health.

Visual inspection of live animals and carcasses can detect birds heavily contaminated with faeces. Such birds increase the risk of cross-contamination during slaughter and may consequently constitute a food safety risk. If such birds/carcasses are dealt with adequately, this risk can be reduced. Visual detection of faecal contamination of carcasses at *post mortem* inspection can also be an indicator of slaughter hygiene, but other approaches to verify slaughter hygiene are considered more appropriate.

Ante-mortem examination is carried out only on birds in a sample of crates, usually the most accessible ones, and the observation of individual birds in the crates is not easy. When *ante-mortem* examination is conducted on the farm, the risk of spreading infections within and between the farms when the inspector visits several poultry houses in one day is increased.

The high speed of the slaughter lines reduces the sensitivity of detection of lesions or carcass contamination by visual inspection. Thus, proper control cannot be achieved for all carcasses and, at best, only a sample of the birds can be thoroughly examined.

Current *ante-mortem* and *post-mortem* visual inspection are not able to detect any of the public health hazards identified as the main concerns for food safety. It would therefore be expected that more efficient procedures could be implemented to monitor the occurrence of non-visible hazards.

4. Recommend new inspection methods for the main public health hazards related to poultry meat that are not currently addressed by meat inspection

4.1. Introduction

As identified by risk ranking earlier in this opinion, the principal biological hazards associated with poultry meat are *Campylobacter* and *Salmonella*, including strains resistant to antimicrobials most critical for the treatment of humans such as cephalosporins and fluoroquinolones (WHO, 2007). *E. coli* with resistance to third-generation cephalosporins (ESBLs/AmpC) can also infect humans and are good indicators of the occurrence of antimicrobial resistance. These were therefore also identified as constituting a relevant public health risk. None of these hazards can be detected by traditional visual meat inspection, which is focused on identification of visible abnormalities and issues relating to the health and welfare of the birds on the farm, in transit and at the abattoir before slaughter. Changes are therefore necessary to identify and control microbiological hazards, and this can be most readily achieved by improved use of FCI and interventions based on risk.

4.2. Proposal for an integrated food safety assurance system for the main public health hazards related to poultry meat

A comprehensive food safety assurance system for poultry meat, combining a range of preventive measures and controls applied both on the farm and at the abattoir in a longitudinally integrated way, is the most effective approach to control the main hazards (*Salmonella*, *Campylobacter*, ESBL-/AmpC-producing *E. coli*) in the context of meat inspection of poultry. The main responsibility for such a system should be allocated to FBOs, whereby compliance is to be verified by the competent authority. A prerequisite for an effective assurance system is the setting of EU measurable targets at the carcass level. Targets at primary production have been defined previously in EU legislation, but the same definitions can be applied at carcass level. For example, according to Regulation (EC) No 2160/2003, Chapter II, Article 4, targets at farm level have been defined as consisting of:

(a) a numerical expression of:

(i) the maximum percentage of epidemiological units remaining positive; and/or

(ii) the minimum percentage of reduction in the number of epidemiological units remaining positive;

(b) the maximum time limit within which the target must be achieved;

(c) the definition of the epidemiological units referred to in (a);

(d) the definition of the testing schemes necessary to verify the achievement of the target; and

(e) the definition, where relevant, of serotypes with public health significance or of other subtypes of zoonoses or zoonotic agents listed in Annex I,[21] column 1, having regard to the general criteria listed in paragraph 6(c) and any specific criteria laid down in Annex III.[21]

For primary production, EU targets to be reached at the national level are already in place for *Salmonella* in breeding flocks of *Gallus gallus* and turkeys, and production flocks of broilers, turkeys and laying hens. Similar targets in primary production could also be considered for the other hazards. In an integrated food safety assurance system for poultry meat, EU targets to be reached at the national level should also be established at the carcass level for the main hazard identified. In this case, the epidemiological unit would be a batch of poultry carcasses or meat and a process hygiene criterion could be used to define what is positive.

[21] Annexes I and III to Reg.(EC) No. 2160/2003.

Targets at carcass level are always required, as they would inform what has to be achieved at earlier steps in the food chain and would help to focus related control measures as well as identifying post-harvest contamination issues. Targets in primary production can be considered if effective intervention methods at the farm level exist. Control at the farm level is regarded as being more sustainable as it is focused on reducing the hazards at the reservoir level, thereby improving the input to the abattoirs and reducing transmission via other exposure routes. For targets at both the abattoir and the flock/batch level, suitable auditing systems should be in place to verify compliance and private test results.

Targets should be risk-based, and can be set on the basis of results from EU-wide baseline surveys using mathematical modelling techniques. Modelling can also be used to decide on the sampling strategy including sampling frequencies and sample sizes.

Based on the above, the following steps for setting targets and implementing monitoring programmes can be identified:

-1. conducting an EU-wide baseline survey at flock and/or carcass level

-2. setting a target at carcass level

-3. setting a target at the flock level, if appropriate

-4. deciding on the design of monitoring programmes to verify whether the targets are met.

The outline of the proposed food safety assurance system is presented in Figure 2. A number of harmonised epidemiological indicators (HEIs) are proposed for the main hazards identified at different levels (EFSA, 2012). It is envisaged that monitoring the main hazards at the farm level by the use of HEIs could be used to categorise the poultry flocks into specific risk categories. This would inform the FCI, which could enable improved risk-based management at the slaughterhouse. Likewise, HEIs at the abattoir level can form the basis for risk classification of the abattoirs, which again can be used for risk management purposes, e.g. by diverting high-risk poultry flocks to abattoirs or specific slaughter lines with high slaughter process hygiene.

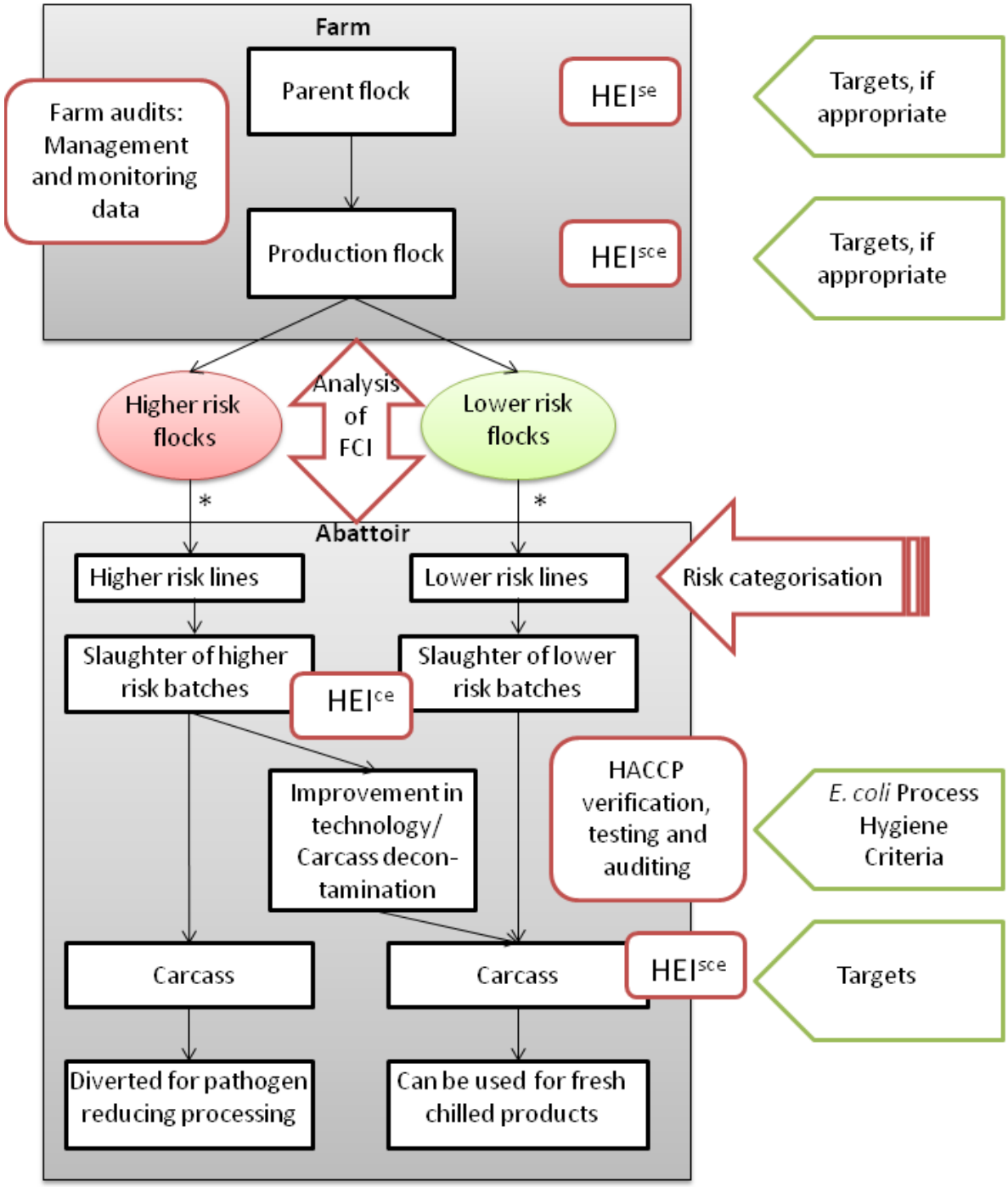


Figure 2: Main elements of a food safety assurance system for the principal public health hazards related to poultry meat. HEI, harmonised epidemiological indicators for *Salmonella* (s), *Campylobacter* (c) or ESBL-/AmpC-carrying *E. coli* (e).

4.2.1. Farm elements of the food safety assurance system

At farm level, the primary goal is reduction of risk for the main hazards, which can be achieved through preventive measures such as flock health programmes, including biosecurity and closed breeding pyramids, good hygiene practices (GHP) and good farming practices (GFP) and finally categorisation of poultry flocks based on the carrier state of the specified pathogens.

Husbandry practices and farm management have evolved dramatically over the past decades, and today a large variety of poultry production systems exist in the EU. Intensively reared poultry (mainly chicken and turkeys) are typically housed in closed integrated production systems with a high degree of biosecurity in order to minimise the risk of introducing infections. Poultry can also be reared with outdoor access (e.g. free range, organic production, farmed poultry game), which accommodates quality parameters other than risk of disease introduction as a priority. Risks are therefore not uniform in all production systems, and part of the risk posed by the flock being colonised by the main pathogens can be explained by the production system on the farm from which it originates.

So, although it is not possible to detect any of the main foodborne zoonotic infections visually at the farm, there are known risk factors, such as outdoor production, multiage production, multispecies site, use of partial depopulation (i.e. thinning), poor biosecurity, visible levels of farm pests (e.g. rodents, flies, litter beetles, wild birds), poor house entry procedures, medication practices, excessive litter moisture/leaking drinkers/non-municipal/untreated water, and a dirty cluttered site, that are likely to increase the risk of infection with the main hazards (Doyle and Erickson, 2012). Other factors, such as poor procedures for cleaning and disinfection between flocks, can also be associated with longer term persistence of organisms that cannot be detected by *ante-mortem* inspection. Information on the use of specific risk-reducing practices may also be used to evaluate the risk of the flock being colonised by the main pathogens.

An important element of an integrated food safety assurance system is, therefore, considered to be risk categorisation of poultry flocks based on the use of farm descriptors and historical data in addition to the flock-specific information, including the microbial test results (i.e. currently for *Salmonella*) that constitute the FCI. Such data could be provided through farm audits using HEIs to assess the risk and preventive factors for the flocks related to each of the prioritised microbiological hazards (see Figure 2 and EFSA (2012)). Some of the observations (e.g. dirty conditions, poor hygiene provision) could also be made by trained leaders of bird-catching teams or by private veterinary surgeons.

Historical data could include information on previous findings of the hazards on the farm premises or in the parent flock(s) from which the flock originates. The FCI could be further improved by requiring suppliers of chicks to provide details of antibiotic medication used on eggs and chicks at the hatchery, or during rearing in situations in which there is two-site production, as in much of the turkey industry. Data on the use of important antimicrobials, such as cephalosporins or fluoroquinolones, in parent breeding flocks and even in primary breeding flocks that supply parent birds for the slaughter generation could also be provided if suitable systems were in place. An assessment of the historical data over a time period could also be used for adjusting the sampling frequency of the main hazards in order to focus control efforts where the risk is highest.

A structured approach to gathering more detailed farm information should become an additional, farm-related element of the FCI that, in combination with the monitoring results for the main hazards, should form the basis for the risk categorisation of the flocks. The frequency of monitoring in higher risk farms could be adapted in a cost-efficient manner, e.g. there would be no need to sample every flock to be slaughtered if the result is very likely to be “high risk” or “very low risk”. Thus, flocks from higher risk farms could be systematically directed to, for example, logistic slaughter, specific slaughterhouses or treatments such as decontamination at the abattoir until these high-risk farms demonstrated a decreased risk following the implementation of adequate on-farm measures. This system could act as an incentive for the primary producer to improve farm standards by means of reduced monitoring costs associated with low-risk status.

As previously described in section 3.2, the current FCI provides details that include *Salmonella* testing results for the current flock, mortality rates, medication, age, weight, thinning status of the slaughter batch, etc. Where this information is consistent and accurately completed and is used by veterinary inspectors at the abattoir, it can be very useful for assessing required levels of inspection or for scheduling flocks, but sometimes the supply and use of the information is suboptimal. It is therefore recommended that a new food safety assurance system should include FCI collected through electronic systems, as described in Regulation (EC) No 853/2004, Annex II, Section III, point 4 (b), which do not allow flocks to be registered for slaughter unless all required information is provided in a timely way.

4.2.2. Abattoir elements of a food safety assurance system

At abattoir level, the primary goal is the risk reduction for the main hazards that can be achieved through integrated programmes based on good manufacturing practices (GMP)/ good hygiene practices (GHP) and HACCP, including:

- control of feed withdrawal times in order to reduce defecation during transportation, to reduce faecal shedding during defeathering and to facilitate evisceration during slaughter (EFSA, 2011a)

- logistic slaughter based on the risk categorisation of the slaughtered flocks; this could be slaughter of higher risk flocks at the end of the day, on special days (at the end of the week), at separate slaughter lines or even at different abattoirs

- hygienic practices and technology-based measures aimed at avoiding direct and indirect cross-contamination with the main hazards

- interventions such as the scheduling of higher risk flocks for carcass decontamination or for risk-reducing processes such as heat- or freezing-based treatments to reduce loads of pathogenic microorganisms.

Once the targets mentioned in section 4.2 above are set for carcasses, achieving them depends on following: (a) the presence/level of the hazards in incoming birds; and (b) the abattoir process hygiene. Both these aspects need to be effectively controlled, if the targets are to be achieved in a predictable and reliable manner. The occurrence or level of the main hazards in the incoming birds may be controlled by setting targets in primary production and/or handling birds according to their flock's infection status as reported by the FCI. Abattoir process hygiene contribution to achieving targets is primarily through technology- and hygiene-based preventive measures to reduce direct and indirect cross-contamination.

The differentiation of slaughterhouses on their contamination reduction capacity could be a way of sending flocks presenting specific risk levels to adapted slaughter lines or slaughterhouses. For example, high-risk flocks might be directed to a specific category of slaughterhouses having suitable equipment to reduce the contamination of carcasses and to achieve an acceptable risk-reduction/contamination level in the final product.

Collection and analysis of data over time would, in addition, enable continuous monitoring of the abattoirs' performance and thereby act as an indicator of the efficiency of the technology- and hygiene-based processes in reducing the final microbial load of the carcasses. Such analyses could indicate whether the abattoirs are improving or whether they might be failing to maintain previously high standards. An assessment of historical data could also be used for adjusting the sampling frequency of the main hazards in order to focus control efforts where the process hygiene does not ensure satisfactory sanitary conditions.

A structured approach to gather more detailed slaughterhouse information related to their equipment and the efficiency of microbial process controls should become an additional element that could form the basis for the risk categorisation of the slaughterhouses.

4.2.2.1. Classification of abattoirs according to technological capacity to control contamination

The main hazards identified are carried in the gastrointestinal tract and/or on the feathers of birds presented for slaughter, and carcasses become contaminated due to direct or indirect cross-contamination that is highly dependent on the slaughterhouse technology. Although technical aspects of individual steps of the poultry slaughter line may vary considerably between slaughterhouses, the type and generally the order in which these steps are carried out are less variable and are generally as follows: transport/lairaging – stunning – bleeding – scalding – defeathering/plucking – neck slitting/foot removal – evisceration – washing – chilling (see contractor's report[19]).

Each of these steps contributes differently to the final microbial load of the carcass. Cross-contamination between flocks and/or individual birds can occur from transport and lairaging and during the slaughter process. Transport crates can be a source of contamination even when they have been disinfected (Berrang et al., 2001; Ellerbroek et al., 2010; Slader et al., 2002). *Campylobacter* prevalence on chicken carcasses decreases immediately after scalding and chilling, and increases after defeathering and evisceration (Berrang et al., 2001; Guerin et al., 2010; Hue et al., 2010; James et al., 2006; Rasschaert et al., 2006; Rosenquist et al., 2006; Tsola et al., 2008). Primary chilling reduces the numbers and prevalence of pathogenic and spoilage microorganisms on poultry carcasses (James et al., 2006). Freezing carcasses is also an effective intervention to reduce *Campylobacter* prevalence on carcasses (Rosenquist et al., 2006; Stern and Robach, 2003).

Within each of these steps, a great variety of technical systems exists, and they also contribute differently to the final microbial load of the carcass. The design of the defeathering machine influences the pattern of microbial contamination: the contrarotating machine contributes to a higher contamination of carcasses than the disc machine (Allen et al., 2003). Despite the limited human handling (Tsola et al., 2008), the risk of cross-contamination is increased when the evisceration is fully automatic (Hue et al., 2011). As the machinery cannot adapt itself to the natural variation in size of carcasses within a given batch, rupture of viscera is common and the release of intestinal contents can contaminate the carcasses eviscerated (Hue et al., 2010; Hue et al., 2011; Rosenquist et al., 2006). Both air chilling and water spray chilling decrease *Campylobacter* contamination of the carcasses and the reductions obtained are not significantly different (Rosenquist et al., 2006). However, a greater reduction in contamination is observed when immersion chilling is used (James et al., 2006).

Decontamination treatments for carcasses are one way of reducing contamination and can be divided into physical and chemical treatments. Physical interventions include water-based treatments, irradiation, ultrasounds, air chilling or freezing. Hot water, steam, electrolysed water and irradiation effectively reduce the bacterial load. Chemical interventions comprise organic acids and chorine- or phosphate-based treatments. Acetic and lactic acid, acidified sodium chlorite and trisodium phosphate reduce the bacterial load (Loretz et al., 2010). Some combinations of treatments further enhance the reductions (Loretz et al., 2010). However, some of these methods are limited by their practicability, regulatory requirements or acceptability to consumers (ACMSF, 2005). Thus, the best way to achieve reductions in carcass contamination is likely to come either from physical decontamination treatments, or from technological developments in the process that are designed to improve hygiene, as long as they are acceptable to the industry and the consumer.

Each slaughterhouse can be viewed as unique, owing to differences in poultry species slaughtered, logistics, processing practices, plant layout, equipment design and performance, standardised and documented procedures, personnel motivation and management, and other factors. These variations individually and in combination lead to between-slaughterhouse differences in risk-reduction capacities and, consequently, in the microbiological status of the final carcass. A few studies have reported the variability of poultry slaughterhouses in respect to the microbiological status of carcasses.

A relationship was reported between slaughterhouse operational hygiene inspection scores and *Campylobacter* contamination in broiler carcasses (Habib et al., 2012). Consequently, a risk categorisation of slaughterhouses is possible, based on the assessment of individual hygiene process performance. For that, a standardised methodology and criteria for assessment of process hygiene is a prerequisite.

4.2.2.2. Process hygiene criteria (PHC) using of *E. coli* as indicator of faecal contamination

E. coli is a normal inhabitant of the intestinal tract of birds and warm-blooded mammals, and is commonly used as an indicator of faecal contamination and hygienic food handling and processing. There is a general recognition in the scientific literature that indicator microorganisms are better suited for use in process hygiene assessment than pathogenic microorganisms (Blagojevic et al., 2011; Bolton et al., 2000; Koutsoumanis and Sofos, 2004). This is principally because pathogens occur in animals/on carcasses at highly variable frequencies. In addition, they are often more difficult to count/quantify and require more laborious handling in better equipped laboratories. Currently, *Salmonella* is used to demonstrate an acceptable level of contamination as part of PHC, but, for the reasons above, the use of *E. coli* or *Enterobacteriaceae* should be considered. Pathogen testing is valuable for the purposes of consumer exposure assessment and pathogen reduction programmes, and for such purposes *E. coli* cannot replace testing for pathogens as these can still occur on carcasses when levels of indicator organisms are low. However, the presence of generic *E. coli* at high levels indicates the presence of intestinal material, which is considered to be a measure of slaughter hygiene (Ghafir et al., 2008; Habib et al., 2012; USDA, 1996).

Altekruse et al. (2009) evaluated whether the number of *E. coli* bacteria in carcass rinses from chicken slaughter establishments could be monitored for the purpose of microbial process control and made conclusions supporting the use of *E. coli* as a specific indicator of faecal contamination in the context of process hygiene.

A post-chill mean log10 *E. coli* colony-forming units (CFUs)/ml carcass rinse value of 1.1 provided a useful reference for the design of a process control plan (Griffith, 1996), defining two distinct groups of establishments: those with higher versus those with lower means. This value also suggested a possible tolerance above the mean for the purpose of process control. With additional information confirming expected *E. coli* numbers during poultry processing, control plans may be developed that define acceptable frequencies of small, medium and large deviations above the process mean (Griffith, 1996) and other quality control measures (e.g. moving averages or the cumulative sum control chart (CUSUM) method, as described by Hayes et al. (1997)).

Some regulatory agencies and food manufacturers have recognised the potential utility of *E. coli* numbers as a measure of slaughter process control. For example, USDA's HACCP rule (USDA, 1996) specifies two criteria for evaluating process control: establishments are to maintain fewer than 100 CFUs/ml of *E. coli* in 80 % of poultry carcass rinses and never exceed 1 000 CFUs/ml.

Other studies have been performed to define and assess precise *E. coli* performance criteria for poultry (Ghafir et al., 2008), to monitor microbial reduction during slaughter processing (Gill et al., 2006), and to validate interventions to reduce microbial numbers on poultry (Stopforth et al., 2007).

Most experiences with the use of *E. coli* as a process hygiene indicator are from the USA, and there are only limited data in the scientific literature on the quantitative levels of *E. coli* and on poultry carcasses from slaughterhouses in the EU and the usefulness of these as process hygiene criteria.

In the EU, *Enterobacteriaceae* have also proved to be useful as indicators for process hygiene in other animal species such as pigs and cattle (Arthur et al., 2004; Blagojevic et al., 2011, 2012).

Measuring *E. coli* or *Enterobacteriaceae* on poultry carcasses at the end of the slaughter line could, therefore be a means of verifying the efficiency of microbial process controls that are designed to

ensure sanitary conditions on carcasses. It is recommended that the use of *E. coli* or *Enterobacteriaceae* for such purposes in poultry meat inspection is further investigated.

4.3. Inspection methods for *Salmonella* in the integrated system

4.3.1. Farm element (options for control)

For *Salmonella*, the system of monitoring, sampling and testing is harmonised in breeding flocks of *Gallus gallus*, laying hens producing table eggs, broilers and turkeys according to Regulation (EC) No 2160/2003 of the European Parliament and of the Council on the control of *Salmonella* and other specified foodborne zoonotic agents. The results of the monitoring of *Salmonella* are passed on to the next part of the food chain by means of the FCI according to Regulation (EC) No 853/2004, laying down specific hygiene rules for food of animal origin.

All commercial-scale broiler and turkey flocks are required to be sampled for *Salmonella* using boot swabs or boot swabs plus dust during a 3-week period before slaughter (this can be extended to 6 weeks in the case of sequentially depopulated turkey flocks or slow-growing broiler breeds). Further typing of *Salmonella* strains, by traditional or more rapid validated molecular methods, can allow the application of different control measures in relation to the relevance of the detected organism. Presently, in broilers and turkey flocks *S.* Enteritidis and *S.* Typhimurium are identified by EU legislation as serovars with special public health significance, and reduction targets in primary production are defined for these two serovars. MSs can always take measures against a wider range of serovars, and the list of relevant strains must be constantly updated, taking into consideration the possible emergence of new or more virulent strains, antimicrobial resistance, and the prevalence in both humans and animals of serovars that can be characteristic of a specific country or geographical area (EFSA, 2011c).

The samples taken at the flock level for broiler and turkey breeders, and for broilers and turkeys before slaughter, are identical to the HEIs proposed by EFSA (2012) (Figure 2). The isolates from these samples should as a minimum be serotyped and tested for antimicrobial resistance and stored for a minimum period, e.g. 3 years, to allow retrospective molecular or epidemiological analyses to be carried out.

Knowledge of the *Salmonella* status of both parent and production flocks can be used by flock owners to consider whether certain management factors related to *Salmonella* risk need to be changed. Contaminated feed, vertical and pseudovertical transmission (via hatcheries) and persistent contamination of holdings are the major sources of *Salmonella* in commercial broiler production (EFSA, 2011c). Finding *Salmonella* in a parent flock, at the hatchery or in a previous flock (i.e. a flock housed in the same housing facilities) could therefore trigger intensified monitoring in order to detect a potential infection at the earliest possible stage. A rigorous clean-down of the housing facilities after a *Salmonella* diagnosis is always warranted.

Detection of ESBL/AmpC and/or fluoroquinolone-resistant *Salmonella* in a flock may lead to an assessment of the current strategy for antimicrobial usage at the farm in question and/or at the farm of the parent flock or hatchery. If inappropriate usage is observed, the reasons for this can be explored and corrective action taken.

The results of the on-farm flock testing can be used to divert flocks for logistic slaughter, as is already the practice in many MSs. Logistic slaughter can consist of scheduling the flock for slaughter at the end of the day and/or before a thorough clean-down of the slaughter line and/or at separate slaughter lines. However, in some countries or regions, where the flock prevalence is low, positive flocks may also be allocated for slaughter in special abattoirs, thereby attempting to keep most abattoirs free of *Salmonella* contamination.

4.3.2. Abattoir element (options for control)

As mentioned above, *Salmonella*-positive poultry flocks can be referred to logistic slaughter to minimise cross-contamination of birds/carcasses from *Salmonella*-negative flocks. However, carcasses originating from *Salmonella*-positive flocks may also undergo *Salmonella*-reducing treatments such as heat treating or other types of carcass decontamination.

The slaughter of *Salmonella*-positive poultry flocks/batches may not only result in the contamination of carcasses but also of the slaughter line (Corry et al., 2002; Olsen et al., 2003). Several studies in pig abattoirs have shown that such slaughterline contamination may reside in the slaughter equipment for a long period and cause carcass contamination (Hald et al., 2003; Smid et al., 2012; Swanenburg et al., 2001; Warriner et al., 2002). A recent study performed in three Belgian broiler abattoirs indicated that contamination of equipment with resident *Salmonella* strains may also play an important role in the contamination of broiler carcasses with *Salmonella* (Rasschaert et al., 2007). It is therefore recommended that the effect of the cleaning and disinfection process performed after the slaughter activities has on *Salmonella* reduction be monitored and corrective actions are taken if cleaning is insufficient. This can be done by comparing the findings of *Salmonella* strains/subtypes in the incoming flocks/batches with the findings on the carcasses. If there is no association between the findings pre and post harvest, and if the same strains are found on the carcasses over a period of time, the possibility of "house strain" contamination should be investigated.

4.3.3. Poultry populations at greater risk (e.g. spent hens)

In a previous opinion, the BIOHAZ Panel concluded that there are insufficient data to quantitatively evaluate the risk associated with human consumption of meat from spent hens, but it was anticipated that the prevalence of *Salmonella* (including *S.* Enteritidis) might be higher in spent hens than in meat from broiler flocks, in particular if sourced from *Salmonella*-positive laying hen flocks (EFSA, 2010c). This is based on an evaluation of several factors such as flock age, immunocompromised stage at the end of lay, extraintestinal infection and poorly adapted slaughter equipment (e.g. increased cross-contamination during slaughter due to technical limitations when using processing premises intended for broiler flocks, or age-related conditions or variation in the size of the birds, making it difficult to remove the intestinal tract cleanly) that may result in a higher prevalence of *Salmonella*-contaminated spent hen meat when compared with broiler meat. Prevalence data for broiler and spent hen meat are currently not reported separately, but in Belgium, in 2008, a total of 91 *Salmonella*-positive batches out of 200 of spent hens were included in the reporting of *Salmonella* in broiler flocks (EFSA and ECDC, 2010) out of a total of 342 *Salmonella*-positive flocks (total of 8 148 flocks tested). However, as the prevalence of *S.* Enteritidis in laying hen flocks in most MSs has been decreasing recently, the assumed difference in prevalence between broiler and spent hen meat must also be expected to be reduced.

There is also evidence of a seasonal effect with higher levels of *Salmonella* infection present in the autumn (Angen et al., 1996; van der Fels-Klerx et al., 2008).

In contrast to the situation for *Campylobacter* and *Toxoplasma*, free-range production often appears to be associated with a reduced risk for *Salmonella* infection. This may be partly associated with the smaller size of flocks and the higher age of birds at sampling (Snow et al., 2008).

4.4. Inspection methods for *Campylobacter* in the integrated system

4.4.1. Farm element (options for control)

The public health benefits of controlling *Campylobacter* in primary broiler production are expected to be greater than control later in the chain as the bacteria may also spread from farms to humans by pathways other than broiler meat. Strict implementation of biosecurity in primary production may prevent or reduce colonisation of broilers with *Campylobacter* and thus subsequent contamination of carcasses. In addition, the use of fly screens, restriction of slaughter age, or discontinued thinning may

further reduce flock colonisation but have not been tested widely and/or may interfere strongly with commercial processes. In low-prevalence situations, risk classification of flocks could be applied. Positive flocks/batches could be allocated to the production of frozen or heat-treated products, and/or subjected to carcass decontamination. Colonised flocks/batches may also be sent for slaughter at special abattoirs or slaughter lines specially equipped to handle high-risk flocks/batches.

The same boot swabs as used for *Salmonella* testing can also be used to detect early infection with *Campylobacter*, but later infections – which are common – would be missed. It is therefore desirable to take the samples to detect *Campylobacter* as close to slaughter as possible and to use a rapid detection method such as polymerase chain reaction. Data from two countries indicated that, when testing 4 days before slaughter, 75 % of the colonised flocks are detected. It should be noted that *Campylobacter* are fragile organisms and more careful sampling, transit and handling techniques involving appropriate transport medium and cool transit conditions are normally required. Details of the sampling and analytical methodology for this HEI are described in EFSA (2012).

4.4.2. Abattoir element (options for control)

The EU-wide baseline study provided indications that there are slaughterhouse-specific differences between the numbers of *Campylobacter* on broiler carcasses when slaughtering colonised flocks (EFSA, 2010b). Although these differences are as yet unexplained, they indicate that slaughter hygiene may contribute importantly to lower consumer risks, even when slaughtering colonised flocks, and possibly omitting the need for further decontamination treatments. Therefore, the BIOHAZ Panel evaluated the public health benefits of improved processing hygiene, as evaluated by microbiological criteria. A public health risk reduction of above 50 % or above 90 % could be achieved if all batches complied with microbiological criteria with a critical limit of 1 000 or 500 CFUs/g of neck and breast skin, respectively, whereas 15 % and 45 % of all tested batches would not comply with these criteria. Thus, establishment of a quantitative target/microbiological criterion for fresh broiler carcasses is an efficient way of protecting public health.

The scientific opinion on *Campylobacter* in broiler meat production also discussed and assessed a wide range of control options and targets at different stages of the food chain by a quantitative microbiological risk assessment in relation to the expected impact on public health (EFSA, 2011a). Relevant aspects related to the abattoir, including *post*-slaughter interventions, are summarised below.

After slaughter, a 100 % risk reduction can be reached by irradiation or cooking of broiler meat on an industrial scale, if recontamination is prevented. More than 90 % risk reduction can be obtained by freezing carcasses for 2–3 weeks. A 50–90 % risk reduction can be achieved by freezing for 2–3 days, hot water or chemical carcass decontamination. Such treatments could be applied either to carcasses from flocks that previously tested positive for *Campylobacter* (scheduled slaughter) or to flocks classified as high risk based on other information such as season, thinning, outdoor access, farm history, etc. In low-prevalence situations, the number of batches that need treatment (and hence the cost) is greatly reduced by scheduling. It should be noted that logistic slaughter is not considered effective for the purposes of controlling *Campylobacter* contamination of carcasses at slaughterhouse level, as described in the aforementioned opinion (EFSA, 2011a).

4.4.3. Poultry populations at greater risk (e.g. outdoor flocks)

In most countries, it can be assumed that slaughter batches from flocks with outdoor access or flocks that have been thinned more than 3 days previously are likely to be positive for *Campylobacter* and could be directly allocated to a higher risk category. In summer, this would even apply to countries with an overall lower flock prevalence.

4.5. Inspection methods for ESBL/AmpC in the integrated system

4.5.1. Farm element (options for control)

Antimicrobial usage is recognised as the main risk factor for occurrence of ESBL-/AmpC-producing strains of *E. coli*. In regions where prophylactic cephalosporin treatment is routinely used for the majority of day-old chicks, poultry meat is considered to be a more prominent source of human ESBL-/AmpC-carrying *E. coli* infection (Martin et al., 2012; Wasyl et al., 2012). This results in very strong selection pressure and preferential development of a high proportion of resistant organisms in the intestinal flora of broilers, which persists until slaughter, resulting in high numbers of resistant *E. coli* that are likely to contaminate carcasses during the slaughter process. In other countries cephalosporins may be used for parent chicks only. In this situation, the level of resistant organisms is likely to recede as the birds mature, especially if the flock is subsequently moved to clean laying accommodation. There is some risk of the persistence of resistant organisms into the laying phase and subsequent transfer via hatching eggs and hatchery contamination into commercial broiler chicks. Cephalosporins are generally not used during the growing phase, but it is common for other antimicrobials such as lincomycin/spectinomycin, amoxicillin or tetracyclines to be used routinely in day-old broiler chicks or turkeys. The extent to which the use of such products might co-select for *E. coli* with ESBL or AmpC genes is unknown but should be investigated via controlled research studies.

Reduction in prophylactic medication of poultry and improved husbandry to reduce the need for regular therapeutic treatment are required to minimise selection pressure while at the same time ensuring that terminal hygiene of poultry houses is sufficient to prevent carryover of resistant organisms between flocks (EFSA, 2011b; Randall et al., 2011). Avoiding the use of cephalosporins such as ceftiofur in poultry hatcheries within the breeding pyramid is considered to be the most effective method of rapidly reducing the occurrence of ESBL-/AmpC-producing *E. coli* in the poultry industry (Anonymous, 2012; EFSA, 2011b). This has been carried out in, for instance, Quebec, Canada, where the use of ceftiofur in hatcheries was temporarily withdrawn, which resulted in a decrease in resistance to cephalosporin in birds originating from these hatcheries (Dutil et al., 2010; PHAC, 2007). In other countries where cephalosporins are not used in the poultry industry, the observed occurrence of ESBL-/AmpC-producing *E. coli* is lower, but still apparent (Anonymous, 2010b, 2011c), which may be explained by carryover of resistant strains from imported day-old grandparent chicks, as described above.

The monitoring of antimicrobial usage at farm or hatchery level could be a part of the FCI and be used to calculate, for example, animal defined doses (ADDs) per flock/animal, per poultry company or per prescribing veterinarian, so that excessive usage can be readily identified and dealt with. In the Danish VetStat database (Stege et al., 2003), the ADD is adopted as a standardised measure for antimicrobial consumption to allow for comparison between different antimicrobial compounds and age groups of treated animals (Jensen et al., 2004). In July 2010, a "yellow card" system for control of antimicrobial use in pig production in Denmark was introduced. This control imposes preventive measures in herds with the highest consumption per pig. Immediately after the introduction of the yellow card a 13 % reduction in overall antimicrobial consumption was observed (Anonymous, 2010b).

It is also important to ensure that standards of cleaning and disinfection and pest control in hatcheries and on farms are sufficiently robust to avoid carryover and recycling of resistant organisms. This should be achieved by paying attention to optimum housing, nutrition and management so that the need for medication is reduced (Smith, 2011).

Despite an increasing number of publications linking *E. coli* in poultry with human infection there is still a lack of harmonised information on prevalence, types of *E. coli*, plasmid types and genetic mechanisms that occur in both poultry and humans in the EU. A baseline survey of poultry caecal contents at slaughter and poultry carcasses/meat would facilitate gathering of such data and help to inform further analyses of the currently unknown quantitative contribution of the poultry reservoir to human infections. It is also recommended that monitoring be carried out for ESBL- and AmpC-

producing *E. coli* at farm level and in hatcheries in order to follow the situation closely, using harmonised methodology.

4.5.2. Abattoir element (options for control)

At present it is difficult to suggest specific measures for the resistant strains. General measures to prevent or reduce carcass contamination would also be effective for resistant organisms. Decisions on scheduling of slaughter or decontamination could be taken based on monitoring data in the FCI relating to the presence of resistant organisms at flock level.

4.6. Conclusions and recommendations

None of the main public health hazards associated with poultry meat can be detected by traditional visual meat inspection. Changes are therefore necessary to identify and control these microbiological hazards, and this can be most readily achieved by improved FCI and interventions based on risk.

An integrated food safety assurance system is outlined, including clear and measurable targets indicating what FBOs should achieve in respect to a particular hazard. These should be set as EU targets to be reached at the national level for prevalence and/or concentration of the hazards in poultry carcasses and, when appropriate, in poultry flocks before slaughter.

Harmonised monitoring and targets are already in place for *Salmonella* in breeding flocks of *Gallus gallus* and turkeys, laying hens producing table eggs, broilers and fattening turkey flocks. This could be extended to other main hazards if effective intervention methods at the farm level can be applied or if the data obtained are useful for subsequent risk management.

To meet these targets and criteria, a variety of control options for the main hazards are available, at both farm and abattoir level. A number of these measures have been described and assessed in earlier EFSA opinions.

An important element of an integrated food safety assurance system is risk categorisation of poultry flocks based on the use of farm descriptors and historical data in addition to the flock-specific information, including the harmonised monitoring results. Farm-related data could be provided through farm audits using HEIs to assess the risk and protective factors for the flocks related to the given hazards.

An assessment of the historical data over a time period could also be used for adjusting the sampling frequency of the main hazards in order to focus control efforts where the risk is highest.

A “risk history” for the holding to be recorded in the FCI could also facilitate future prospective logistic selection or remedial action, as it can be difficult for poultry companies in practice to correctly schedule slaughter or organise product placement based on the testing results from the actual flock sent for slaughter.

Classification of abattoirs according to their capability to prevent or reduce faecal contamination of carcasses can be based on two elements: (1) the technologies applied including installed equipment and the HACCP programmes in place; and (2) the process hygiene as measured by, for example, the level of indicator *E. coli* or *Enterobacteriaceae* on the carcasses (i.e. PHC).

The differentiation of abattoirs could provide a way of sending flocks presenting specific risk levels to adapted slaughter lines or abattoirs. For example, high-risk flocks might be directed to a specific category of abattoirs having suitable equipment and having demonstrated the ability to reduce the contamination of carcasses and to achieve an acceptable risk reduction/contamination level in the final product.

For abattoirs with an increased level of contamination, improvement of slaughter hygiene should be sought, for instance through technological developments.

The performance of the abattoirs should be monitored, and a "risk history" of the abattoirs should be registered. Historical data could also form the basis for adjusting sampling frequency and sample sizes.

Collection of baseline data and development of approaches for assessing abattoir process hygiene through the use of indicator *E. coli* or *Enterobacteriaceae* and the use of such results for risk categorisation of abattoirs is recommended.

Appropriate methods for interpreting monitoring results of ESBL-/AmpC-producing *E. coli* and their association with antimicrobial usage should be developed.

All parties involved in the proposed integrated food safety assurance system, including official veterinarians, official auxiliaries, abattoir staff and farmers, should be trained in the skills required for operating the new system.

5. Recommend adaptation of inspection methods that provide an equivalent protection for current hazards

5.1. Food Chain Information

Currently in the EU, the use of FCI for food safety purposes is limited except for *Salmonella* control. Despite these limitations, FCI could provide a valuable tool for risk management decision and can be used for risk categorisation of flocks/batches. To achieve this, the system needs further development to include additional information important for food safety, including definition of appropriate and standardized indicators for the main public health hazards.

An important element of an integrated food safety assurance system is risk categorisation of poultry flocks based on the use of farm descriptors and historical data in addition to the flock-specific information, including the harmonised monitoring results. Farm-related data could be provided through farm audits using harmonised epidemiological indicators to assess the risk and protective factors for the flocks related to the given hazards.

5.2. *Ante-mortem* inspection

Meat for human consumption should be derived from the slaughter of healthy animals. This opinion is focused on microbiological hazards associated with the handling, preparation and consumption of poultry meat. It is therefore not relevant to consider in detail the important role of *ante-mortem* inspection in helping to safeguard animal welfare and health by assessing the "normality" of birds on arrival at the abattoir. Inspection of birds on arrival is, however, an important regulatory procedure that helps to enforce acceptable standards of bird transport and handling that might indirectly contribute to maintenance of operating procedures that minimise the general risk associated with unhygienic and stressful management of food animals. Stress has been shown to be an important factor in the multiplication and excretion of foodborne zoonotic pathogens such as *Salmonella* and *Campylobacter* in animals after transport to slaughter (EFSA, 2011a), so inspection procedures that result in prevention of unnecessary stress are likely to be beneficial.

The inspector at the abattoir normally obtains a limited view of birds delivered in crates so only major problems affecting a large proportion of birds can be expected to be detected. Visual inspection relating to the birds' behaviour, strength and standing ability is easier to achieve in gas systems if birds are gradually tipped from crates on to conveyor belt systems before stunning. Video imaging technology during unloading of crates and shackling of birds might further facilitate detection of abnormalities.

Ante-mortem inspection does not directly contribute to the detection of the public health hazards identified as relevant in this document, but it can help to detect conditions such as diarrhoea and/or extensive faecal contamination. Birds that are excessively dirty on arrival could be externally contaminated with bacterial pathogens that may subsequently contaminate the slaughter plant. In this case, a break in the slaughter process could be introduced after processing the contaminated batch to allow for cleaning and disinfection of the slaughter line as mentioned earlier. A constant supply of dirty birds by individual producers could be the subject of feedback, advice or penalties that could be lifted after improvements are made. Details of such issues may be facilitated by high-quality video surveillance, which could also help with monitoring the welfare of birds on arrival at the slaughter plant and during shackling.

Findings at the abattoir revealing recurrent problems with heavily contaminated birds, or batches, that are routinely positive for the main public health hazards identified in section 2, should be shared with the farm operator for appropriate action, which would normally be done in consultation with the farm veterinarian. On farm *ante-mortem* inspection could be used (as is currently the case in some MSs) for farms having such recurring problems as identified through the FCI.

In conclusion, *ante-mortem* inspection does not directly contribute to the detection of the main public health hazards, but it can help to detect birds heavily contaminated with faeces and to assess the general health status and welfare of the flock. Taking this into consideration, and given that current methods do not increase the microbiological risk to public health, no adaptations for the existing visual *ante-mortem* inspection are found to be required. Introduction of new or improved technologies (e.g. video surveillance) may be considered in order to increase the sensitivity of the visual inspection.

5.3. *Post-mortem* inspection

The only way that current visual *post-mortem* inspection contributes to preventing/reducing microbial risk to public health is by detecting heavy contamination of carcasses by faecal material and/or spilled intestinal content. However, the direct effect of faecal contamination on public health risk is difficult to demonstrate because of the scarcity of focussed comparative studies, the variable occurrence of pathogens in poultry flocks and the different methods needed to assess general contamination and the occurrence of specific pathogens (Jimenez et al., 2002). In addition, the sensitivity of visual inspection to detect faecal contamination at high line speeds is considered to be low (Cho et al., 2009; Park et al., 2005), although camera-based technology may to some extent enhance the reliability and sensitivity (Yoon et al., 2011). For these reasons, it is proposed that the current visual inspection is replaced by a) the establishment of targets for the main hazards on the carcass; and b) verification of the FBO own hygiene management through the use of PHC, as described in section 4. It should be noted, however, that current visual meat inspection procedures *post-mortem* do not increase the microbiological risk to public health, unless the carcasses are handled as a consequence of the visual findings leading to cross contamination. It has been shown that good process technology and hygiene can very successfully minimise contamination of carcases even when *Salmonella*-positive broiler flocks are slaughtered (EFSA, 2010e).

Methods for reduction of viscera rupture during evisceration or an enhanced washing procedure for birds with ruptured viscera can be potential management options for reducing the microbial load on slaughtered poultry. The full automation of evisceration without a permanent check during the process can result in high frequencies of ruptured viscera and self- or cross-contamination of the batch or equipment. A calibration system for sorting carcasses from the same batch according to their size category could be implemented by slaughterhouses, before starting the evisceration process. A computer system could thus adjust parameters of the machinery for evisceration operation (Hue et al., 2011).

On the other hand, if important emerging meatborne diseases detectable by visual *post-mortem* inspection appear in the future, it would be preferable to inspect a statistically relevant subset of birds from each slaughter batch in more detail, rather than to inspect every bird. This could be done by automatically or manually transferring a random selection of birds from the main slaughter line to a separate inspection line. Also, in the future, rapid methods that are capable of detection of major food-borne pathogens, resistance genes or chemical contaminants in real-time may become available and could be used on such a sample of birds from each slaughter batch.

5.4. The effects of proposed changes on hazards/conditions addressed by current meat inspection

The proposed FCI-related changes of the poultry meat inspection will not have any negative effect on hazards/conditions addressed by current meat inspection. In contrast, it is expected that proposed wider, more systematic and better focused use of the FCI will have positive impact on control of those hazards/conditions as well as on control of emerging hazards.

As indicated previously, no change of *ante-mortem* inspection is proposed, so there will be no effect of proposed new poultry meat inspection system on hazards/conditions addressed by current *ante-mortem* inspection.

It is assessed that cessation of visual *post-mortem* inspection as proposed above would not increase public health risk associated with poultry carcasses as none of the conditions that can be detected in a reliable way are relevant for public health.

Current visual *post-mortem* inspection is also aimed at detecting aesthetically undesirable carcass characteristics that would make the carcass unmarketable if presented for retail sale and/or would affect the keeping qualities of the carcasses. Such visual and sensory quality issues could be designated as the sole responsibility of the FBO, leaving official inspectors and assistants free to concentrate exclusively on food safety and general hygiene inspection. Increased use of video imaging would be valuable for FBOs to help detect visual abnormalities (see contractors report[19]).

5.5. Conclusions and recommendations

A wider, more systematic and better focused use of the FCI will have positive impact on control of the main public health hazards associated with poultry meat.

Ante-mortem inspection does not directly contribute to the detection of the hazards identified as relevant in this document, but it can help to detect birds heavily contaminated with faeces and to assess the general health status of the flock. Taking this into consideration, no adaptations to the existing visual *ante-mortem* inspection are found to be required.

Current *post-mortem* inspection methods do not directly contribute to preventing microbiological risks to public health, except by detecting heavily contaminated carcasses. The sensitivity of visual inspection to detect faecal contamination is considered to be low and there is no direct association with the occurrence of pathogens. Therefore, it is proposed that the current visual inspection process is replaced by the establishment of targets for the main hazards on the carcass and by verification of the FBO's own hygiene management through the use of PHC.

Current *post-mortem* inspection does not increase the microbiological risk to public health unless the carcasses are handled as a consequence of the visual detection of abnormalities, leading to cross-contamination.

Elimination of abnormalities on aesthetic/meat quality grounds can be ensured through a meat quality assurance system and not through the official food safety assurance system including meat inspection. Any handling should be performed on a separate line and accompanied with laboratory testing as required.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

TOR 1: Identify and rank the main risks for public health that should be addressed by meat inspection at EU level. General (e.g. sepsis, abscesses) and specific biological risks as well as chemical risks (e.g. residues of veterinary drugs and contaminants) should be considered. Differentiation may be made according to production system and age of animals (e.g. breeding compared to fattening animals).

- A decision tree was developed and used for risk ranking poultry meat-borne biological hazards. Hazards that are introduced and/or for which the risk to public health relates to growth that occurs during processing steps after carcass chilling were not considered. The risk ranking was based on the following criteria: (I) the magnitude of the human health impact; (II) the severity of the disease in humans; (III) the proportion of human cases that can be attributable to the handling, preparation and/or consumption of poultry meat; and (IV) the occurrence (prevalence) of the identified hazards in poultry flocks and carcasses. The risk ranking did not consider the different poultry species separately.

- Based on the risk ranking, the hazards were classified as follows:

  – *Campylobacter* spp. and *Salmonella* spp. were considered of high public health relevance for poultry meat inspection.

  – ESBL/AmpC gene-carrying bacteria were considered to be of medium to high (*E. coli*) and low to medium (*Salmonella*) public health relevance.

  – In the case of *C. difficile*, data for ranking were insufficient, but, based on the limited information available, the Panel assessed the risk at the present time to be low.

  – The remaining identified hazards were considered to be of low public health relevance, based on available data. For the low-risk hazards, no hazard-specific control measures are currently implemented at the farm and/or slaughterhouse level. These hazards were therefore not considered further.

TOR 2: Assess the strengths and weaknesses of the current meat inspection methodology and recommend possible alternative methods (at *ante-mortem* or *post-mortem* inspection, or validated laboratory testing within the frame of traditional meat inspection or elsewhere in the production chain) at EU level, providing an equivalent achievement of overall objectives; the implications for animal health and animal welfare of any changes suggested in the light of public health risks to current inspection methods should be considered.

- The main elements of the current poultry meat inspection are analysis of FCI, *ante-mortem* examination of animals, and *post-mortem* examination of carcasses and organs. The assessment of the strengths and weaknesses of the current meat inspection was focused on the public health risks that may occur through the handling, preparation and/or consumption of poultry meat.

<u>Strengths</u>

- FCI is being used as part of *ante-mortem* inspection and provides in particular information related to veterinary treatments and disease occurrence during rearing helps focus the *ante-mortem* inspection on flocks with an animal health concern. Currently in the EU, the use of FCI for microbial food safety purposes is limited to *Salmonella* control, where it provides a valuable tool for risk management decision making.

- *Ante-mortem* inspection can be used to verify FCI given by the farmer and to provide feedback to producers on problems detected, but usually for issues not related to public health.

- Visual inspection of live animals can detect birds heavily contaminated with faeces. Such birds increase the risk of cross-contamination during slaughter and may consequently constitute a food safety risk. If such birds/carcasses are dealt with adequately, this risk can be reduced.

- Visual detection of faecal contamination of carcasses at *post mortem* inspection can also be an indicator of slaughter hygiene, but other approaches to verify slaughter hygiene are considered more appropriate.

Weaknesses

- In practice, FCI lacks adequate and standardised indicators for the main public health hazards identified. Exceptions are the results of the harmonised monitoring of *Salmonella* in broiler and turkey flocks before slaughter, although the use of *Salmonella* testing results for risk management varies widely among MSs.

- Current *ante-mortem* and *post-mortem* visual inspection are not able to detect any of the public health hazards identified as the main concerns for food safety.

- *Ante-mortem* examination is carried out only on birds in a sample of crates, usually the most accessible ones, and the observation of individual birds in the crates is not easy. When *ante-mortem* examination is conducted on the farm, the risk of spreading infection within and between farms when the inspector visits several poultry houses in one day is increased.

- The high speed of the slaughter lines reduces the sensitivity of detection of lesions or carcass contamination by visual inspection. Thus, proper control cannot be achieved on all carcasses and only, at best, a sample of the birds can be thoroughly examined.

TOR 3: If new hazards currently not covered by the meat inspection system (e.g. *Salmonella, Campylobacter)* are identified under TOR 1, then recommend inspection methods fit for the purpose of meeting the overall objectives of meat inspection. When appropriate, food chain information should be taken into account.

- None of the main public health hazards associated with poultry meat can be detected by traditional visual meat inspection. Other approaches are therefore necessary to identify and control these microbiological hazards, and this can be most readily achieved by improved FCI and interventions based on risk.

- An integrated food safety assurance system is outlined, including clear and measurable targets indicating what FBOs should achieve in respect to a particular hazard. These should be set as EU targets to be reached at the national level for prevalence and/or concentration of the hazards in poultry carcasses and, when appropriate, in poultry flocks before slaughter.

- Harmonised monitoring and targets are already in place for *Salmonella* in breeding flocks of *Gallus gallus*, and turkeys, flocks of laying hens producing table eggs, broiler flocks and fattening turkey flocks. This could be extended to other main hazards if effective intervention methods at the farm level can be applied or if the data obtained are useful for subsequent risk management.

- To meet these targets and criteria, a variety of control options for the main hazards are available, at both farm and abattoir level. A number of these measures have been described and assessed in earlier EFSA opinions.

- An important element of an integrated food safety assurance system is risk categorisation of poultry flocks based on the use of farm descriptors and historical data in addition to the flock-specific information, including the harmonised monitoring results. Farm-related data could be provided through farm audits using HEIs to assess the risk and protective factors for the flocks related to the given hazards.

- An assessment of the historical data over a time period could also be used for adjusting the sampling frequency of the main hazards in order to focus control efforts where the risk is highest.

- A "risk history" for the holding to be recorded in the FCI could also facilitate future prospective logistic selection or remedial action, as it can be difficult for poultry companies in practice to correctly schedule slaughter or organise product placement based on the testing results from the actual flock sent for slaughter.

- Classification of abattoirs according to their capability to prevent or reduce faecal contamination of carcasses can be based on two elements: (1) the technologies applied including installed equipment and the HACCP programmes in place; and (2) the process hygiene as measured by, for example, the level of indicator *E. coli* or *Enterobacteriaceae* on the carcasses (i.e. PHC).

- The differentiation of abattoirs could provide a way of sending flocks presenting specific risk levels to adapted slaughter lines or abattoirs. For example, high-risk flocks might be directed to a specific category of abattoirs having suitable equipment and having demonstrated the ability to reduce the contamination of carcasses and to achieve an acceptable risk-reduction/contamination level in the final product.

- For abattoirs with an increased level of contamination, improvement of slaughter hygiene should be sought, for instance through technological developments.

- The performance of the abattoirs should be monitored, and a "risk history" of the abattoirs should be registered. Historical data could also form the basis for adjusting sampling frequency and sample sizes.

TOR 4: Recommend adaptations of inspection methods and/or frequencies of inspections that provide an equivalent level of protection within the scope of meat inspection or elsewhere in the production chain that may be used by risk managers in case they consider the current methods disproportionate to the risk, e.g. based on the ranking as an outcome of terms of reference 1 or on data obtained using harmonised epidemiological criteria (see Annex 2[22]). When appropriate, food chain information should be taken into account.

- A wider, more systematic and better focused use of the FCI will have positive impact on control of the main public health hazards associated with poultry meat.

- *Ante-mortem* inspection of poultry does not directly contribute to the detection of the hazards identified as having public health relevance, but it can help to detect birds heavily contaminated with faeces and to assess the general health status of the flock. Taking this into consideration, no adaptations to the existing visual *ante-mortem* inspection are found to be required.

- Current *post-mortem* inspection methods do not directly contribute to preventing microbiological risks to public health, except by detecting heavily contaminated carcasses. The sensitivity of visual inspection to detect faecal contamination is considered to be low and

[22] Annex 2 of the original European Commission mandate.

there is not a direct association with the occurrence of pathogens. Therefore, it is proposed that the current visual inspection process is replaced by the establishment of targets for the main hazards on the carcass and by verification of the FBO's own hygiene management through the use of PHC.

- Current *post-mortem* inspection does not increase the microbiological risk to public health unless the carcasses are handled as a consequence of the visual detection of abnormalities, leading to cross-contamination.

- Elimination of abnormalities on aesthetic/meat-quality grounds can be ensured through a meat quality assurance system and not through the official food safety assurance system including meat inspection. Any handling should be performed on a separate line and accompanied with laboratory testing as required.

RECOMMENDATIONS

- Poultry, particularly broilers, are recognised as a reservoir for ESBL-/AmpC-producing *E. coli*, but the occurrence in most EU MSs is not known. An EU-wide baseline survey for ESBL-/AmpC-producing *E. coli* to investigate the role of poultry meat as a source of human exposure is therefore recommended. Specific recommendations for the preferred methods for detection and characterisation of these resistant bacteria, as well as for harmonised monitoring of this resistance, were given in a recent EFSA Opinion.

- Because the hazard identification and ranking relates to the EU as a whole, refinements reflecting differences among regions or production systems are recommended if/where hazard monitoring data indicate.

- Furthermore, as new hazards might emerge and/or hazards that presently are not a priority might become more relevant over time or in some regions, both hazard identification and the risk ranking are to be revisited regularly to reflect this dynamic epidemiological situation.

- To provide a better evidence base for future risk ranking of hazards, initiatives should be instigated to:

  – improve data collection of incidence and severity of human diseases caused by relevant hazards;

  – systematically collect data for source attribution;

  – collect data to identify and risk rank emerging hazards that could be transmitted through handling, preparation and consumption of poultry meat.

- FCI provides a valuable tool for *Salmonella* risk management decision making. This can be extended to other hazards of public health relevance and thereby can be used for risk categorisation of flocks/batches. To achieve this, the system needs further development to include additional information important for food safety.

- Research on the optimal ways of using the collected FCI data for risk categorisation of poultry flocks/batches, as well as approaches for assessing the public health benefits (e.g. by means of source attribution methods) is required.

- Collection of baseline data and development of approaches for assessing abattoir process hygiene through the use of indicator *E. coli* or *Enterobacteriaceae* and the use of such results for risk categorisation of abattoirs is recommended.

- Appropriate methods for interpreting monitoring results of ESBL-/AmpC-producing *E. coli* and their association with antimicrobial usage should be developed.
- All parties involved in the proposed integrated food safety assurance system, including official veterinarians, official auxiliaries, abattoir staff and farmers, should be trained in the skills required for operating the new system.

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ANNEXES

A. MICROORGANISMS OF POULTRY ORIGIN THAT MAY BE TRANSMISSIBLE TO HUMANS

Hazard	Poultry species or order[1]	Poultry meat-borne transmission[2]
Bacteria		
Aeromonas hydrophila	Chicken, turkeys	No
Arcobacter spp.	Chicken	No
Bacillus cereus toxin	Chicken, anseriformes	Yes
Brucella	Turkeys	No
Burkholderia pseudomallei	Anseriformes	No
Campylobacter spp. (thermophilic)	Chicken, turkeys, anseriformes	Yes
Clostridium botulinum toxin	Chicken, turkeys, anseriformes	Yes
Clostridium difficile	Chicken, turkeys	Yes
Clostridium perfringens toxin	Chicken, turkeys, anseriformes	Yes
Chlamydophila (Chlamydia) psittaci	Chicken, turkeys, anseriformes	No
Escherichia coli (toxicoinfectious strains including VTEC)	Chicken, turkeys, anseriformes	Yes
Enterococcus faecium	Chicken	No
Enterococcus faecalis	Chicken	No
Erysipelothrix rhusiopathiae	Chicken, turkeys, ducks	No
Extended spectrum and/or AmpC β-lactamases (ESBL/AmpC)	Chicken	Yes
Haemolytic streptococci	Chicken	No
Helicobacter canadensis	Goose	No
Helicobacter pullorum	Turkeys	No
Listeria monocytogenes	Chicken, turkeys, anseriformes	Yes
Methicillin-resistant *Staphylococcus aureus*	Chicken, turkeys	No
Mycobacterium avium	Chicken	No
Mycobacterium genavense	Anseriformes	No
Pasteurella spp.	Chicken, anseriformes (multocida)	No
Plesiomonas shigelloides	Chicken	No
Salmonella spp. (non-typhoidal)	Chicken, turkeys, anseriformes	Yes
Staphylococcus aureus toxins	Chicken, turkeys, anseriformes	Yes
Yersinia enterocolitica	Chicken	Yes
Yersinia pseudotuberculosis	Turkeys, anseriformes	No
Viruses		
Avian influenza virus	Chicken, turkeys	No
Avian leucosis retrovirus	Chicken	No
Circoviruses	Chicken	No
Hepatitis E virus	Chicken, turkeys	No
Newcastle disease virus	Chicken	No
Marek's disease virus	Chicken	No
West Nile virus	Chicken, turkeys	No
Protozoa		
Cryptosporidium spp.	Chicken, turkeys, anseriformes	No
Toxoplasma gondii	Chicken	Yes
Trichomonas gallinae and *anseris*	Anseriformes	No
Helminths		
Ascaris	Anseriformes	No
Centrocestus formosanus	Chicken	– (not relevant in EU)
Echinostoma cinetorchis	Chicken	– (not relevant in EU)
Hypoderaeum conoideum	Chicken	– (not relevant in EU)
Toxocara canis	Chicken	No
Toxocara cati	Chicken	No

Hazard	Poultry species or order[1]	Poultry meat-borne transmission[2]
Fungi		
Cryptococcus neoformans	Chicken	No
Histoplasma capsulatum	Chicken	No
Microsporum canis and *gypseum*	Ducks	No
Trychophyton gallinae	Chicken	No

[1] Anseriformes (order comprising birds of the families Anhimidae, Anatidae and Anseranatidae); chicken (*Gallus gallus*); duck (belonging to either *Anas platyrhynchos* or *Cairina moschata*); goose (belonging to either *Anser anser domesticus* or *Anser cygnoides*); turkey (*Meleagris gallopavo*).
[2] Risk of infection at household level by handling, preparation or consumption of poultry meat.

B. FOOD CHAIN INFORMATION IN THE UK: ACTIONS IMPLEMENTED ACCORDING TO THE ON FARM *SALMONELLA* TESTING STATUS

Table B1. Example of actions implemented according to the *Salmonella* on-farm testing status of the poultry flock, UK (Manual for Official Controls, Chapter 2.1: FCI and CCIR, Section 2, Amendment 41)

***Salmonella* on-farm testing status**	**Food business operator action**	**Official veterinarian action**
Missing	• Must notify the official veterinarian (OV)	In the first instance, the OV should request that the food business operator (FBO) contact the primary producer of the flock, to determine whether an oversight has occurred and the appropriate information is available Where the primary producer confirms that the test result is available, the OV must ensure that a copy of the test result is sent or faxed to the slaughterhouse. Once received by the FBO, action should be taken with the consignment in accordance with the test result received Where this fails to resolve the issue, the OV should request an audit check of the premises. Necessary action will be taken if the establishment is found to be non-compliant The flock should then be processed as if a positive result had been received, followed by a full clean-down
Positive	• Retain the affected flock and slaughter it at the end of a production run, or, alternatively, slaughter the flock at the end of the day • In either case, a full clean-down must be made after processing the flock • Where a positive batch has been processed in error in the middle of a production run, then the production run should be stopped as soon as the affected batch has been processed, and a full clean-down take place before any further processing commences • Following production, in the absence of any relevant *ante-* or *post-mortem* findings, the carcases can enter the food chain as normal	• Check that the procedure has been followed in accordance with the FBO's HACCP-based food safety management system • Notify the inspection team that the flock is positive, and ensure that the appropriate judgement on pericarditis is followed in accordance with the information contained on the Manual for Official Controls Where non-compliance is found, action should be taken in accordance with the hierarchy of enforcement
Negative	• Scheduled slaughter of the flock	

HACCP, hazard and critical control point.

C. CONDEMNATION RATES AND REASONS FOR CONDEMNATION

Table C1. Estimations of condemnation rates in broiler chickens for several countries (EU and others) from published studies

Country	Year of study	Source population	Epidemiological unit	Number of units	Species	Calculation unit	Condemnation (%)	Reference
Brazil	2007	Two slaughterhouses	Carcass	40 732 773 and 6 457 166	Chicken	Number	8.3 and 3.6	Santana et al., 2008
Canada	1980–1985	One slaughterhouse	Batch	NS[1]	Chicken	Number	2.18 and 1.39	Ansong-Danquah, 1987
Canada	1986–1994	Exhaustive: national database	Carcass	331 115 170 and 449 862 563	Chicken	Number	1.77 and 1.86	Olkowski et al., 1996
Canada	1991–1992	One slaughterhouse	Carcass	9 826 296	Chicken	Number	1.48	Herenda and Jakel, 1994
Czech Republic	1989–1994 1995–2000	NS	Carcass	407 025 923 607 588 325	Chicken	Number	1.25 0.99	Kozak et al., 2002
Denmark	1975–1976	Six slaughterhouses	Slaughterhouse	6	Chicken	Number	0.8 and 1.0	Bisgaard et al., 1977
France	2009–2010	650 farmers of 21 departments	Batch	NS	Chicken	Weight	0.87	Anonymous, 2010
France	2005	15 slaughterhouses in western France, representing 60 % of national production	Batch	404	Chicken	Number	0.87	Lupo et al., 2008
Germany	1989	2 slaughterhouses	Batch	6	Chicken	Weight	1.57	Fries and Kobe, 1992
Iran	2002–2006	11 slaughterhouses in Fars province, representing 6 % of national production	Carcass	130 967 021	Poultry	Number	0.732	Ansari-Lari and Rezagholi, 2007
Netherlands	1970–1978	Seven slaughterhouses	Slaughterhouse	NS	Chicken	Weight	0.24	Veerkamp, 1982
Poland	1986–1991	Slaughterhouses in Olztyn district	Carcass	23 861 855	Chicken	Number	1.27	Radkowski et al., 1996
Poland	1996–1999	NS	Carcass	1 055 900 000	Chicken	NS	0.45	Libelt, 2001
Switzerland	1995–1996	Two slaughterhouses	Batch	30	Chicken	Number	1.01	Jakob et al., 1998
United Kingdom	1992–1993	93 % of slaughterhouses	Carcass	39 756 222	Chicken	Number	1.3	Bremner, 1994
United Kingdom	1992	One slaughterhouse representing 5.6 % of national production	Batch	1280	Chicken	Number	1.57	Yogaratnam, 1995
United Kingdom	2003–2005	Eight slaughterhouses belonging to five integrated broiler companies	Batch	150	Chicken	Number	1.23	Haslam et al., 2008
United States	1986–1989	Four slaughterhouses	Slaughterhouse	4	Chicken	Number	0.95	Weinstock et al., 1995
United States	1988–1997	Exhaustive: national database	Carcass	NS	Chicken	Number	0.97	Cervantes, 1999
United States	2011	310 slaughterhouses, representing 99 % of national slaughterhouses located in 38 states	Carcass	8 683 067 000	Chicken	Weight	0.87	NASS, 2011

NS, not specified.

Table C2. Condemnation reasons in poultry (chicken or turkey) for several countries (EU and others) from published studies: relative frequencies of sanitary reasons (in percentage, the most frequent reason is highlighted in grey)

Country / Reasons	Brazil		Canada						Denmark	United States			France		Iran	Poland		United Kingdom			Switzerland
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Disease conditions																					
Cellulitis				17.6	15.1	20.3	38.6	15.1													
Emaciation/cachexia	1st		34.8	14.9	13.8	11.0	10.1	2.6	17.6				42.1	38	37.7	66.6		2nd	19.5	18.7	14.1
Airsacculitis						7.4	3.2	47.9		3.4	24.4	16.9					0.02		42.8		
Arthritis ± synovitis				0		0.6		1.7	13.4	2.5	0.8	0.2	5.5	17	0.3				0.31		
Pericarditis				0															1.01		14.2
Hepatitis				5.4	10.5	4.5	4.2	7.4	1.4												
Peritonitis				0		1.1	1.1	9.8	1.4									3rd			
Dermatitis				1.4		0.5															
Congestion/septicaemia						0.1		7.0		33.5	35.9	41.6	22.1	21	24.3			1st	29.63		
Ascites		8.19		17.6	11.2	19.0	22.2						2.6	0.2	1.6			3rd	5.91	16.5	43.5
Cyanosis			40.3[1]	12.2	10.5	12.2	13.2	8.4													
Bruises and wounds	2nd			8.1	34.2	5.9	4.2			0.5	1.7	1.3	10.1	2.1	1.8					2.3	
Respiratory lesions				4.7					27.9						12.1		0.1				
Cutaneous lesions									6.9				11.1	11					0.62	16.3	
Marek's disease			3.0			0.9			0.5						0.7		0.8				
Valgus varus				6.1	4.7	4.4	3.2														
Leucosis									0.1		3.0	0.5					0.01				
Acute internal pathology														2.8						39.9	
Chronic pathology																				0.36	
Abnormal colour									2.4				6.4	8.2						10.1	
Abnormal odour									2.6												
Non-disease conditions																					
Mutilation				5.4					1.1												
Overscald				0						0.2	0.9	0.9			5.5						
Inadequate bleeding				2.0					2.2							24.1					
Cadavers										0.3	4.2	3.5									
Carcass contamination				3.4						1.2	7.0	8.0			2.1						
Other reasons			21.9	1.2[2]		12.2[3]			22.5[4]	58.4	22.0[5]	27.1[6]			13.8[7]	9.3	99[8]		0.17[9]		28.2

A: Santana et al., 2008; B: Jacobsen and Flores, 2008; C: Ansong-Danquah, 1987; D: Herenda and Jakel, 1994; E: Elfadil et al., 1996; F: Olkowski et al.,1995; G: Bielby, 1999; H: Mallia et al., 2000; I: Bisgaard et al., 1977; J: Farver et al., 1981; K : Cervantes, 1999; L: NASS, 2011; M: Lupo et al., 2008; N: Lupo et al., 2010; O: Ansari-Lari and Rezagholi, 2007; P: Libelt, 2001; Q: Radkowski et al., 1996; R: Bremner, 1994; S: Yogaratnam, 1995; T: Haslam et al., 2008; U: Jakob et al., 1998.

[1] Including carcass contamination; [2]pendulous crop 1.2 %; [3]of which abscesses 0.03 %; anaemia 0.09 %, tumours 0.3 %, pendulous crop 1.0 %; [4]of which pendulous crop 3.7 %, fractures 0.9%; [5]tumours 3.9 % and miscellaneous (of which ascites) 18.1 %; [6]tumours 3.4 % and miscellaneous 23.7 %; [7]poisoning 13.3 %, miscellaneous 0.5 %; [8]salmonellosis 4.4 %, coccidiosis 3 %, the remainder is not specified; [9]tumours 0.01 %, icterus 0.16 %.

D. THIRD-GENERATION CEPHALOSPORIN RESISTANCE IN INDICATOR *E. COLI* AND *SALMONELLA* ISOLATES FROM POULTRY AND POULTRY MEAT

Data on the occurrence of resistance to cefotaxime and ceftazidime in *Salmonella* and *E. coli* isolates recovered from poultry and meat thereof have been taken from the EU monitoring data when available (EFSA, 2012). As reports cover only phenotypic monitoring, it is not possible to determine the class or exact type of β-lactamase enzyme that is likely to confer the resistance detected to third-generation cephalosporins. MS-specific data reported on the occurrence of resistance to cefotaxime and ceftazidime in *Salmonella* and *E. coli* isolates from poultry and meat thereof are shown in the tables below.

Third-generation cephalosporin resistance in indicator* E. coli *isolates from poultry and poultry meat.

Resistance (%) to cefotaxime and ceftazidime in indicator *E. coli* isolates from *Gallus gallus* by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Austria	171	0.6	–	–
Denmark	118	0	–	–
France	201	3.5	201	2.5
Germany	1 201	4.5	1 201	4.6
Netherlands	284	18.3	284	17.6
Sweden	181	1.1	–	–
Total (six and three MSs)	**2 156**	**5.4**	**1686**	**6.5**

*No MSs reported results for fewer than 10 isolates.

Resistance (%) to cefotaxime and ceftazidime in indicator *E. coli* isolates from turkeys by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Germany	483	1.7	483	1.2
Total (only one MS)	**483**	**1.7**	**483**	**1.2**

*Only one MS reported data.
**No MSs reported results for fewer than 10 isolates.

Resistance (%) to cefotaxime and ceftazidime in indicator *E. coli* isolates from broiler meat by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Denmark	158	0.6	–	–
Sweden	77	0.0	–	–
Total (two MSs)	**235**	**0.4**	**–**	**–**

*No MSs reported results for fewer than 10 isolates.

Resistance (%) to cefotaxime and ceftazidime in indicator *E. coli* isolates from turkey meat by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Germany	289	2.1	289	1.7
Total (only one MS)	**289**	**2.1**	**289**	**1.7**

*Only one MS reported data.
**No MSs reported results for fewer than 10 isolates.

NO DATA on resistance (%) to cefotaxime and ceftazidime in indicator *E. coli* isolates from Anseriformes by Member State in 2010

NO DATA on resistance (%) to cefotaxime and ceftazidime in indicator *E. coli* isolates from meat from Anseriformes by Member State in 2010

Third generation cephalosporin resistance in* Salmonella *isolates from poultry and poultry meat

Resistance (%) to cefotaxime and ceftazidime in *Salmonella* spp. isolates from *Gallus gallus* by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Austria	192	1	192	1
Cyprus	12	0	–	0
Czech Republic	375	1.3	375	0.8
Denmark	50	0	–	–
France	323	0	–	–
Germany	386	2.3	386	2.3
Ireland	35	5.7	35	5.7
Italy	381	3.1	381	3.1
Latvia	36	0	–	–
Netherlands	193	4.7	193	4.1
Poland	336	0.6	336	0.6
Portugal	82	0	–	–
Slovakia	86	0	86	0
Slovenia	29	0	29	0
Spain	249	0	248	0
Sweden	15	0	–	–
United Kingdom	282	0	–	–
Total (17 and 10 MSs)	**3 062**	**1.3**	**2 261**	**1.7**

*MSs reporting results for fewer than 10 isolates were excluded (only Finland).

Resistance (%) to cefotaxime and ceftazidime in *Salmonella* spp. isolates from turkeys by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Austria	32	0	32	0
Czech Republic	74	0	74	0
France	168	0.6	–	–
Germany	143	0	143	0
Italy	67	0	67	0
Poland	54	1.9	54	1.9
Slovakia	13	0	13	0
Spain	18	0	18	0
United Kingdom	168	0	–	–
Total (nine and seven MSs)	**737**	**0.3**	**401**	**0.25**

*MSs reporting results for fewer than 10 isolates were excluded (DK: one isolate, none resistant; IE: nine isolates, none resistant).

Resistance (%) to cefotaxime and ceftazidime in *Salmonella* spp. isolates from Anseriformes (ducks and geese combined) by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Ireland	65	0	65	0
Latvia	3	0	–	–
Total (two MSs)	**68**	**0**	**65**	**0**

*MSs reporting results for fewer than 10 isolates were included in the table.

Resistance (%) to cefotaxime and ceftazidime in *Salmonella* spp. isolates from broiler meat by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Belgium	182	3.3	182	3.3
Czech Republic	82	0.0	82	0.0
Germany	103	2.9	103	2.9
Greece	17	0.0	16	0.0
Ireland	46	2.2	46	2.2
Netherlands	108	11.1	108	8.3
Slovakia	11	0.0	11	0.0
Total (seven MSs)	**549**	**4.0**	**548**	**3.5**

*MSs reporting results for fewer than 10 isolates were excluded (EE: one isolate, none resistant; IT: five isolates, none resistant; LV: eight isolates, none 0 resistant; SI: two isolates, none positive).

Resistance (%) to cefotaxime and ceftazidime in *Salmonella* spp. isolates from turkey meat by Member States in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Czech Republic	16	0.0	16	0.0
Germany	201	1.0	201	1.0
Ireland	1	0.0	1	0.0
Italy	1	0.0	1	0.0
Latvia	8	0.0	–	–
Netherlands	5	0.0	5	0.0
Slovenia	1	0.0	1	0.0
Total (seven and six MSs)	**233**	**0.9**	**225**	**0.9**

*MSs reporting results for fewer than 10 isolates were included in the table.

Resistance (%) to cefotaxime and ceftazidime in *Salmonella* spp. isolates from Anseriformes (ducks and geese) meat by Member Statess in 2010

Country	Cefotaxime		Ceftazidime	
	n	**% Res**	***n***	**% Res**
Ireland	11	0.0	11	0.0
Total (only one MS)	**11**	**0.0**	**11**	**0.0**

*Only one MS (IE) reported data on duck meat (no information on geese meat).

APPENDIX B FROM THE PANEL ON CONTAMINANTS IN THE FOOD CHAIN (CONTAM PANEL)

SUMMARY

Meat inspection in Europe is specified in Regulation (EC) No 854/2004.[11] The main objective of meat inspection is to ensure that meat is fit for human consumption. Historically, meat inspection procedures have been designed to control slaughter animals for the absence of infectious diseases, with special emphasis on zoonoses and notifiable diseases. The mandate that meat needs to be fit for human consumption, however, includes also the control of chemical residues and contaminants in meat or offal that could be potentially harmful for consumers. This aspect is not fully addressed by the current procedures.

The EFSA Panel on Contaminants in the Food Chain (CONTAM Panel) was asked to identify and rank undesirable or harmful chemical residues and contaminants in poultry. Such substances may occur as residues in edible tissues from the exposure of poultry to contaminants in feed materials as well as following the possible application of non-authorized substances and the application of authorized veterinary medicinal products and feed additives. A multi-step approach was used for the ranking of these potential risks. As a first step, the CONTAM Panel considered substances listed in Council Directive 96/23/EC[8] and evaluated the outcome of the National Residue Control Plans (NRCPs) for the period 2005-2010. It was noted that only approximately 0.27 % of the total number of results was non-compliant for one or more substances listed in Council Directive 96/23/EC[8] and thus chemical substances in poultry are unlikely to pose an immediate or acute health risk for consumers. Consequently, potentially higher exposure of consumers to these residues from poultry or poultry products takes place only incidentally, as a result of mistakes or non-compliance with known and regulated procedures. The CONTAM Panel concluded that lack of detail provided with the reported results from the Member States to the European Food Safety Authority (EFSA) hampers the evaluation and interpretation of data. In the absence of this substance-specific information, such as the tissues used for residue analysis and the actual concentration of a residue or contaminant measured, these data do not allow a reliable assessment of consumer exposure.

As second and third steps, the CONTAM Panel evaluated the likelihood that specific residues or contaminants, including emerging substances, may be present in poultry carcasses and considered also the toxicological profile for each chemical substance. On the basis of these defined criteria, the individual residues and contaminants were ranked into four categories denoted as being of high, medium, low, or negligible potential concern.

Dioxins and dioxin-like polychlorinated biphenyls (DL-PCBs) were ranked as being of high potential concern due to their known accumulation in food-producing animals, the risk of exceedance of current maximum levels, and in consideration of their toxicological profile.

Chloramphenicol and the groups of nitrofurans and nitroimidazoles were ranked as being of high potential concern, as they have a distinct toxicological profile comprising a potential concern for human health and considering that residues in poultry have been found in the course of the NRCPs in various Member States, although these substances are prohibited for use in food-producing animals in the European Union (EU).

Non dioxin-like polychlorinated biphenyls (NDL-PCBs), polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDDs) also accumulate in food-producing animals, but were ranked in the category of medium potential concern, because they are less toxic than dioxins and DL-PCBs. Occurrence data are required for all poultry species to confirm or refute this ranking, in particular for PBDEs and HBCDDs.

Residues originating from other substances listed in Council Directive 96/23/EC[8] were ranked in the low or negligible potential concern category due to the toxicological profile of these compounds and/or the absence or seldom exceedances of maximum residue limits (MRLs) or maximum levels (MLs).

The CONTAM Panel emphasises that this ranking into specific categories of potential concern mainly applies to broilers and turkeys and is based on current knowledge regarding the toxicological profiles, usage in poultry husbandry and likelihood of occurrence of residues and contaminants in poultry. When changes in any of these factors occur, the ranking might need to be reconsidered. Future sampling should take into account differences in animal husbandry practices, feed supplies and life-span of the poultry categories that may result in changes of the likelihood of occurrence of particular residues and contaminants in poultry.

In addition to the ranking of chemical residues and contaminants in poultry, the CONTAM Panel was asked to assess the main strengths and weaknesses of current meat inspection protocols within the context of chemical hazards. The CONTAM Panel noted that current procedures for sampling and testing are in general well-established and co-ordinated including follow-up mechanisms following identification of non-compliant samples. The current system is well-endorsed by sector stakeholders and the regular sampling and testing for chemical residues and contaminants is a disincentive for the development of undesirable practices. Moreover, the prescriptive sampling system allows for equivalence to be achieved for EU domestic poultry. Forthcoming measures have to ensure that the control of imports from Third Countries remains equivalent to the controls within the domestic market. A major weakness is the limited added value of the current visual clinical *ante-mortem* inspection of a flock and of *post-mortem* inspection of the carcasses for the identification of chemical hazards. In addition, NRCPs prescribe the number of samples that need to be taken but do not necessarily take into account actual food chain information related to feed control and environmental monitoring of substances of potential health concern. A further integration and exchange of information between these different activities is recommended.

The CONTAM Panel was also asked to identify and recommend inspection methods for new hazards. As dioxins and DL-PCBs have not yet been comprehensively covered by the sampling plans of the current meat inspection, they should be considered as "new" hazards as they have been ranked as being of high potential concern. Moreover, for a number of organic contaminants that also may accumulate in food-producing animals very limited data regarding residues in poultry are available. This is the case, in particular, for (i) NDL-PCBs, (ii) brominated flame retardants, including PBDEs as well as HBCDDs and the potential occurrence of these substances in poultry carcasses should be monitored to improve human exposure assessment. New technologies such as the production of bioethanol and biodiesel, and the increasing availability of new by-products used as animal feeds from these technical processes are issues of potential concern and hence should be considered in forthcoming control programmes for residues and contaminants.

The CONTAM Panel concluded that the risk profile for individual farms and poultry species vary due to the diversity of poultry farming in the EU. The CONTAM Panel recommends that sampling of poultry carcasses should be based on the available Food Chain Information (FCI), including feed control results. Frequency of sampling for farms should be adjusted accordingly and should be regularly updated in order to include new and emerging substances.

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ASSESSMENT OF CURRENT MEAT INSPECTION PROTOCOLS IN THE IDENTIFICATION OF CHEMICAL SUBSTANCES OF POTENTIAL CONCERN THAT MAY OCCUR AS RESIDUES OR CONTAMINANTS IN POULTRY

1. Introduction

Meat inspection in the European Union (EU) is specified in Regulation (EC) No 854/2004.[8] The main objective of meat inspection is to ensure that meat is fit for human consumption. Historically, meat inspection procedures have been designed to control slaughter animals for the absence of infectious diseases, with special emphasis on zoonoses and notifiable diseases. The mandate that meat needs to be fit for human consumption, however, includes also the control of chemical residues and contaminants in meat or offal that could be potentially harmful for consumers. This aspect is not fully addressed by the current procedures.

This document aims to identify undesirable or harmful chemical residues and contaminants in poultry taking into account the current legislation and the results from the National Residue Control Plans (NRCPs) implemented in line with Council Directive 96/23/EC.[8] These findings, together with the characteristics of the individual substances and the likelihood that a substance will occur in poultry, were used to rank chemical residues and contaminants into categories of potential concern. Four categories were established constituting a high, medium, low or negligible potential concern. In the second part, the main strengths and weaknesses of current meat inspection protocols were assessed within the context of chemical hazards. The ultimate aim is an overall evaluation of the current strategies for sampling and analytical testing, resulting in recommendations for possible amendments to the current meat inspection protocols.

1.1. Poultry meat production figures in the EU

The term "poultry" includes several species within the class of birds (*aves*). In accordance with Council Regulation (EC) No 853/2004[23] poultry means "farmed birds, including birds that are not considered as domestic, but which are farmed as domestic animals, with the exception of ratites". Poultry is also defined in Council Directive 96/23/EC[8] as "broiler chickens, spent hens, turkeys and other poultry". Apart from game and ratidae, the three different orders of birds which are used as food-producing animals, are presented in Table 1.

Table 1: Categories of poultry food-producing species.

Order	**Poultry species**					
Galliformes	Chickens (hens and broilers)	Turkeys	Pheasants	Partridges	Quails	Guinea fowl
Anseriformes	Geese	Ducks				
Columbiformes	Pigeons					

Detailed production data for the different poultry categories are not readily available in the EU. Data from "The community summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in the European Union in 2008" (EFSA, 2010a) indicate that, in 2009, broilers accounted for 86.7 % of the total poultry production, followed by laying hens and turkeys (which accounted for 4.2 % and 3.9 %, respectively). Ducks, guinea fowls, geese, pigeons, pheasants, partridges and quails accounted for the remaining 5.2 %, in descending order of production. It should be noted that the reported figures illustrate the magnitude of production for the different poultry categories but do not reflect the exact numbers of animals produced in the EU since official data were only provided by few Member States (MSs).

[23] Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin. OJ L 139, 30.4.2004, p. 55. Corrected version in OJ L 226, 25.6.2004, p. 22-82.

Production figures (tonnes of meat) from the main poultry species are annually gathered by the Association of Poultry Processors and Poultry Trade in the EU Countries (AVEC). Production figures (partially estimated) for the period 2005-2009 are presented in Table 2.

Table 2: Summary of production of the main poultry species (broilers, turkeys) in the European Union[(a)] during the period 2005-2009 as gathered by AVEC[(b)]. Units expressed as '000 tonnes.

Poultry species	2009	2008	2007	2006	2005
Broilers (*Gallus gallus*)	8 802	8 680	8 522	7 729	7 984
Turkeys *(Meleagris gallopavo)*	1 818	1 860	1 837	1 908	1 975

(a) 25 Member States included until 2007, 27 Member States included from 2007 onwards.
(b) Source: Association of Poultry Processors and Poultry Trade in the EU Countries (AVEC) 2010 report. Data gathered from Marktinfo Eier and Geflugel (MEG), Food and Agriculture Organization of the United Nations (FAO) and national data. Partial provisional or estimated data (official data provided only for a few countries).

Due to the diversity of poultry meat producing species, this document focuses on the main species produced (broilers and turkeys) and any species-specific issue is highlighted when necessary.

1.2. Poultry husbandry practices

On commercial farms, poultry is reared for meat and/or egg production. Age categories presented for slaughter include broiler chickens at the end of the fattening period and spent hens (laying hens) at the end of their productive lives. Turkeys almost exclusively are reared for meat production. Selection of breeds, housing and feeding systems differ between fattening animals and layers and, thus, a uniform keeping/husbandry technique for "poultry" altogether does not exist.

Poultry are kept sometimes under highly sophisticated intensive conditions and sometimes backyard based and, therefore, the number of farmed birds kept in a flock varies considerably. Modern chicken broiler flocks may comprise 15 000 to 40 000 individual birds in one house, generally on a deep litter bedding system. One chicken farm might possess several flocks and in turn the total number of birds in a farm site may reach some 100 000 animals. Feed supplies, transport of broilers to slaughter and other key inputs are often provided on an integrated or cooperative farming system. Similar large-scale operations occur also for turkeys. Ducks and geese are generally kept in smaller operations although in some MSs the number of large farms is increasing. In addition to these large animal production sites, numerous small farm units still exist throughout the EU. Farming of less common poultry species, such as quails, pigeons and other poultry species occurs almost entirely on such smaller farm units.

Numerous factors and management decisions are known to influence the outcome of farming, such as housing and climate control, origin of the flocks, hygiene, nutrition, disease outbreaks and control (including vaccination programmes and medication), housing service periods (with removal of feeding/drinking devices, litter, etc.), cleaning and disinfection, as well as pest control. Importantly, the daily visual check of the birds in their houses will include the control of feeding and drinking facilities, removal of ill and dead birds, and corrective measures. Documentation of these parameters provides an essential part of the food chain information (FCI). Annex II, Section III of Regulation 853/2004[23] establishes the minimum food chain information that poultry farmers should provide regarding the animals intended to be sent to the slaughterhouse. However, as highlighted in an external report to the European Food Safety Authority (EFSA)[12] there is a lack of harmonisation of the FCI standard declaration in the EU. Furthermore, it is unclear how information on veterinary medicinal products (VMPs) and feed additives (anticoccidials or coccidiostats) given to geese, guinea fowls, quails, pheasants and pigeons is provided as a limited number of drugs is authorised for these animals species.

Occurrence of chemical substances as residues in poultry can result following the possible application of non-authorized substances and/or the application of authorized veterinary medicinal products and

feed additives to poultry, normally via feed or water, as well as from exposure to contaminants present in feed materials. Feed for large production units typically comes from industrialised feed mills which may import feed materials from the global market. Fully elaborated feed production chains and standardised internal quality control systems are in place in the vast majority of the highly integrated production units. The latter include a documentation of the origin of the raw materials and ingredients from worldwide sources as well as the quality parameters checked. This documentation also forms part of FCI, indicating compliance with current feed quality regulations.

In addition, there are many farms with minor poultry species such as pheasants, guinea fowl or quails at which animals are kept under less defined conditions, partly indoors and partly outdoors. Also there is an increasing number of organic farms, although their annual production currently represents a minor fraction of the total poultry production. According to data reported by EUROSTAT for organic farming, total organic production for the period 2005-2009 represented on average only 0.23 % of the total poultry production in the EU. The risk profile for these flocks, which potentially may be exposed to environmental contaminants, differs from flocks that are kept indoors.

1.2.1. Transport and slaughter technology

Generally, broilers are slaughtered at 30 to 40 days of age, whereas spent hens are usually slaughtered at around 18 months of age. Turkeys are slaughtered at the age of 12-25 weeks, depending on the gender and the desired market weight. For ducks, the normal slaughter age is at 6 weeks.

Poultry are transported to slaughter as an entire flock (broiler chicks) or according to the desired market weight (small broilers, female turkeys). At the slaughter house, chicken broiler processing is almost fully automated, comprising the following phases:

- Slaughter line
- Evisceration line
- Product diversification (automatic cutting lines)

From the cutting area and during further processing, a diversity of convenience products as well as deep frozen poultry is produced. The quality of the end product is defined for the particular poultry categories as A or B (class of trade), state of preparation (e.g. effile or New York dressed) or state of refrigeration (fresh, frozen, deep frozen). Similar levels of sophistication are being achieved in turkey and duck slaughter and processing, while other poultry species are more often slaughtered and processed in much smaller facilities, which may be on-site or adjacent to the farm.

The EU Marketing Regulations (EEC) 543/2008[24] and 1234/2007[25] address the water content in poultry as the carcasses will take up process water to a certain amount depending on the type of washing and chilling machinery used. Unlike microbiological hazards, additional chemical contamination during slaughter is unlikely to occur as only potable water is permitted for use during water/spray based chilling and no other additives are permitted.

1.2.2. Current meat inspection protocols

In accordance with Annex I of Regulation (EC) No 854/2004[11] all animals should be inspected prior to slaughter (*ante-mortem* inspection) as well as after evisceration (*post-mortem* inspection).

Ante-mortem inspection

The competent authority may decide whether poultry for slaughter shall be inspected at the farm of origin and/or at the slaughterhouse. The *ante-mortem* inspection of poultry consists of a general check of the animals and includes the control of relevant criteria registered at the farm, such as: initial

[24] Commission Regulation (EC) No 543/2008 of 16 June 2004 laying down detailed rules for the application of Council Regulation (EC) No 1234/2007 as regards the marketing standards for poultrymeat. OJ L 157, 17.6.2008, p. 46-87.

[25] Council Regulation (EC) No 1234/2007 of 22 October 2007 establishing a common organisation of agricultural markets and on specific provisions for certain agricultural products (Single CMO Regulation). OJ L 299, 16.11.2007, p. 1. Regulation as last amended by Regulation (EC) No 470/2008 (OJ L 140, 30.5.2008, p.1).

number of one-day-old birds, incidence of diseases and overall mortality rate, treatment (including veterinary medicinal products and feed additives) and vaccination history, feed and water consumption, average daily weight gain and feed conversion ratio, distribution and variability of bird weights. Based on the outcome of this inspection, a health certificate is issued by a veterinarian which accompanies the birds to the slaughterhouse. Birds should be slaughtered within 3 days after on-farm inspection. If the inspection has not been conducted at the farm of origin, it needs to be done directly at the abattoir. Special requirements have been set for poultry reared for the production of specialities such as 'foie gras', or delayed eviscerated poultry obtained at the holding of provenance. In these cases, a special health certificate is required that should accompany the uneviscerated carcases to the slaughterhouse or cutting plant, where an inspection is done.

As part of the *ante-mortem* inspection, the official veterinarian at the slaughterhouse must check the content and completeness of the FCI declaration. Based on the FCI being satisfactory, the flock of birds is accepted for slaughter.

***Post-mortem* inspection**

Each individual animal undergoes a visual inspection of all external surfaces after evisceration. In addition, visual inspection of viscera and cavity of a representative number of animals slaughtered should be conducted. Furthermore, a random sampling of parts, or of entire carcasses, of birds declared unfit for human consumption should be carried out. Inspection comprises any other examination necessary when there is reason to suspect that the meat from the birds could be unfit for human consumption.

In chicken broiler processing, an almost total automation has been achieved. The line speed for broiler chickens in large facilities is 9 000 to 12 000 birds/hour. With the increasing speed of poultry slaughtering and processing lines, the limitations of any visual inspection carried out by humans are obvious. Some feasible options compensating for the high line speed include:

- flock biosecurity control (expansion of food chain information), including control of Good Husbandry Practice guidelines and compliance with Feed Regulations;
- development of automated inspection systems such as computer-aided camera systems and, real-time equipment based on infrared spectrometry or comparable technical aids that detect predefined alterations on a carcass.

Residue control along the chain and during *ante-* and *post-mortem* inspection

Council Regulation (EC) 854/2004[11] prescribes that during *ante-mortem* inspection on-farm, clinical examination of the flock in its environment may be used to identify a disease, including signs of intoxications or of recent medications, which may provide evidence for the potential presence of chemical residues and contaminants. The same regulation also establishes that in suspect cases, the meat from the birds concerned should be declared unfit for human consumption until further investigations have been carried out.

Visual poultry meat inspection is unable to detect chemical contamination on birds and/or carcasses. Even physiological alterations caused to individual organs, as are described for other (larger) animal species, can often not be observed in the much smaller poultry carcasses/organs during rapid visual inspection. Therefore, current inspection strategies do not contribute materially to the identification of abiotic hazards in poultry. Consequently, assessment of the likelihood of chemical residues and/or contaminants occurring in poultry needs to be based in particular on information from the FCI, previous history of problems with chemical residues or contaminants, or other information.

1.3. Current legislation

Council Directive 96/23/EC[8] prescribes the measures to monitor certain substances and residues thereof in live animals and animal products. It requires that MSs adopt and implement a national residue control programme, also referred to as the National Residue Control Plan (NRCP), for defined

groups of substances.[26] MSs must assign the task of coordinating the implementation of the controls to a central public body. This public body is responsible for drawing up the national plan, coordinating the activities of the central and regional bodies responsible for monitoring the various residues, collecting the data and sending the results of the surveys undertaken to the Commission each year.

The NRCP should be targeted; samples should be taken on-farm and at abattoir level with the aim of detecting illegal treatment or controlling compliance with the maximum residue limits (MRLs) for veterinary medicinal products according to Commission Regulation (EU) No 37/2010,[27] with the maximum residue levels for pesticides as set in Regulation (EC) No 396/2005,[28] or with the maximum levels for contaminants as laid down in Commission Regulation (EC) No 1881/2006.[29] This means that in the national control plans, the MSs should target those groups of animals/gender/age combinations where the probability of finding residues is highest. This approach differs from random sampling, where the objective is to gather statistically representative data, for instance to evaluate consumer exposure to a specific substance.

A sample consists of one or more animals depending on the requirements of the analytical methods. The minimum number of samples for each category of poultry (broiler chickens, spent hens, turkeys and other poultry) must at least equal one (1) per 200 tonnes of annual production (deadweight), with a minimum of 100 samples for each group of substances where annual production in the category concerned is over 5 000 tonnes.

The following breakdown must be respected in the national sampling plans:

Group A:[30] 50 % of the total samples.

One fifth of theses samples must be taken at farm level.

Each sub-group of Group A must be checked each year using a minimum of 5 % of the total number of samples to be collected for Group A.

The balance will be allocated according to the experience and background information of the MS.

Group B:[30] 50 % of the total samples.

30 % must be checked for Group B1 substances.

30 % must be checked for Group B2 substances.

10 % must be checked for Group B3 substances.

The balance will be allocated according to the situation of the MS.

1.4. Actions taken as consequence of non-compliant results

In accordance with Article 8 of Directive 96/23/EC,[8] the MSs are requested, as a follow-up, to provide information on actions taken at regional and national level as a consequence of non-compliant results. The Commission sends a questionnaire to the MSs to obtain an overview of these actions, for example when residues of non-authorised substances are detected or when the MRLs established in EU legislation are exceeded. The actions taken by the MSs may include:

- suspect sampling;
- modifications of the national plans;
- other actions taken as a consequence of non-compliant results.

[26] Commission Staff Working Document on the Implementation of National Residue Monitoring Plans in the Member States in 2009 (Council Directive 96/23/EC). Available from http://ec.europa.eu/food/food/chemicalsafety/residues/workdoc_2009_en.pdf.

[27] Commission Regulation (EU) No 37/2010 of 22 December 2009 on pharmacologically active substances and their classification regarding maximum residue limits in foodstuffs of animal origin. OJ L 15, 20.1.2010, p. 1-72.

[28] Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue level of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC. OJ L 70, 16.3.2005, p. 1-16.

[29] Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. OJ L 364, 20.12.2006, p. 5-24.

[30] See Section 2.1 for detailed description of Group A and B as defined by the Council Directive 96/23/EC.

1.4.1. Suspect sampling

Sampling as suspect includes:

- samples taken as a consequence of non-compliant results on targeted samples taken in accordance with the residue control plans (Article 5 of Directive 96/23/EC[8]);
- samples taken as a consequence of possession or presence of prohibited substances at any point during manufacture, storage, distribution or sale throughout the food and feed production chain (Article 11 of Directive 96/23/EC[8]);
- samples taken where the veterinarian suspects, or has evidence of, illegal treatment or non-compliance with the withdrawal period for an authorized veterinary medicinal product (Article 24 of Directive 96/23/EC[8]).

In summary, this means that the term "suspect sample" applies to a sample taken as a consequence of:

- non-compliant results and/or
- suspicion of an illegal treatment and/or
- suspicion of non-compliance with the withdrawal periods

1.4.2. Modification of the national plans

Non-compliant results for a specific substance or group of substances or a specific food commodity should result in intensified controls for this substance/group or food commodity in the plan for the following year.

1.4.3. Other actions

Article 16 and Articles 22-28 of Directive 96/23/EC[8] prescribe a series of actions (other than modifications of the residue control plan) to be taken in the case of non-compliant results or infringements:

- to carry out investigations in the farm of origin, such as verification of records and additional sampling;
- to hold animals in the farm as a consequence of positive findings;
- to slaughter animals in the case of confirmation of illegal treatment and to send them to a high risk processing plant (i.e. rendering plant);
- to intensify the controls in the farms where non-compliant results were found;
- to impound carcasses at the slaughterhouse when non-compliant results have been found;
- to declare the carcasses or products of animal origin unfit for human consumption.

It should be noted that targeted sampling as defined by Directive 96/23/EC[8] aims at monitoring certain substances and residues thereof in live animals and animal products across EU MSs. In contrast to monitoring, under suspect sampling, a "suspect" carcass(es) has to be detained at the abattoir until laboratory results confirm or deny conformity with legislative limits for chemical residues. Based on the test results, the carcass(es) can be declared fit or unfit for human consumption. In the first scenario, the carcass(es) is released into the human food chain whereas in the second case the carcass(es) is disposed of.

1.4.4. Self-monitoring residue testing

In addition to the minimum testing requirements which form part of the NRCPs, the Council Directive 96/23/EC[8] also establishes the requisites for self-monitoring and co-responsibility on the part of operators.

In accordance with Article 9, chapter III, of Directive 96/23/EC,[8] MSs shall ensure that the owners or persons in charge of the establishment of initial processing of primary products of animal origin (slaughterhouses) take all necessary measures, in particular by carrying out their own checks, to:

- accept only those animals for which the producer is able to guarantee that withdrawal times have been observed;

- satisfy themselves that the farm animals or products brought into the slaughterhouse do not contain residue levels which exceed maximum permitted limits and that they do not contain any trace of prohibited susbtances or products.

The poultry farmers and the food processing operators (slaughterhouses) must place on the market only:

- animals to which no unauthorized substances or products have been administered or which have not undergone illegal treatment;
- animals where authorized products or substances have been administered, the withdrawal periods prescribed for these products or substances have been observed.

2. Identification, classification and ranking of substances of potential concern

2.1. Identification of substances of potential concern

In the current EU legislation, chemical residues and contaminants in live animals and animal products intended for human consumption are addressed in Council Directive 96/23/EC.[8] Identification and ranking of potential concerns within this chapter includes all chemical compounds listed in this Council Directive. Annex I of Council Directive 96/23/EC[8] groups substances that may be found in animal tissues into two categories:

Group A – Substances having anabolic effects and unauthorized substances

A.1. Stilbenes, stilbene derivatives, and their salts and esters
A.2. Antithyroid agents
A.3. Steroids
A.4. Resorcyclic acid lactones, including zeranol
A.5. Beta-agonists
A.6. Compounds included in Annex IV to Council Regulation (EEC) No 2377/90 of 26 June 1990[31] (recently amended by Commission Regulation (EC) No 37/2010[27]).

Group B – Veterinary drugs (including unlicensed substances which could be used for veterinary purposes) and contaminants

B.1. Antibacterial substances, including sulphonamides, quinolones
B.2. Other veterinary drugs
  a) Anthelmintics
  b) Anticoccidials
  c) Carbamates and pyrethroids
  d) Sedatives
  e) Non-steroidal anti-inflammatory drugs (NSAIDs)
  f) Other pharmacologically active substances
B.3. Other substances and environmental contaminants
  a) Organochlorine compounds, including polychlorinated biphenyls (PCBs)
  b) Organophosphorus compounds
  c) Chemical elements
  d) Mycotoxins
  e) Dyes
  f) Others

For poultry, analysis for residues and contaminants for all the above substances are required under Council Directive 96/23/EC[8] with the exception of B2d - Sedatives, B2f – Other pharmacologically active substances, B3b – Organophosphorus compounds, B3e – Dyes, and B3f – Others.

[31] Council Regulation (EEC) No 2377/90 of 26 June 1990 laying down a Community procedure for the establishment of maximum residue limits of veterinary medicinal products in foodstuffs of animal origin. OJ L 224, 18.8.90, p. 1-8.

2.2. Classification of chemical substances in the food chain

As one of the objectives of this assessment of current meat inspection protocols is the identification of chemical substances of potential concern that may occur as residues or contaminants in poultry, but have not been specifically addressed in Council Directive 96/23/EC[8] a more general grouping of chemical substances was chosen, resulting in the following three major groups:

- substances that are prohibited for use in food-producing animals, corresponding to Group A substances in Council Directive 96/23/EC,[8]
- veterinary drugs, also denoted veterinary medicinal products (VMPs), corresponding to Groups B1 and B2 substances in Council Directive 96/23/EC,[8] and
- contaminants, corresponding to Group B3 substances in Council Directive 96/23/EC.[8]

The **first group** of chemicals that may occur in edible tissues as residues are substances that are prohibited for use in food-producing animals. The rationale for banning these substances for application to animals varied and the list of prohibited substances comprises substances that are of toxicological concern (including veterinary medicinal product for which an acceptable daily intake (ADI) could not be established), as well as anabolic substances and substances that may alter meat quality and/or affect animal health and welfare.

A **second group** of chemicals that may be a source of residues in animal-derived foods are VMPs (including antibiotics, antiparasitic agents and other pharmacologically active substances) and authorized feed additives used in the health care of domestic animals. These substances have been subjected to assessment and pre-marketing approval by the Committee for Medicinal Products for Veterinary Use of the European Medicines Agency (EMA) according to Regulation (EC) No 470/2009[32] or are licensed as feed additives following a review of the EFSA Panel on Additives and Products or Substances used in Animal Feed (FEEDAP Panel) according to Regulation (EC) No 1831/2003.[33] For all VMPs and feed additives licensed for use in food-producing animals, an ADI is established on the basis of the pharmacological and toxicological profile of the candidate drug/additive. Compounds that are genotoxic or carcinogenic and substances for which no toxicological ADI can be established are excluded from approval. On the basis of the established ADI, MRLs are derived for the parent drug and/or its biologically active metabolites (marker metabolites) in edible tissues and these MRL values (µg/kg tissue) are used to establish compliance. The list of allowed substances is presented as Annex 1 of Commission Regulation (EC) No 37/2010[27] and in the Community Register of feed additives. With regard to antibiotics, it is important to state that the ranking of substances of concern in this part of the document considers only toxicological concerns related to the presence of residues. Other aspects, such as the emergence of antimicrobial resistance is considered by the EFSA Panel on Biological Hazards (BIOHAZ Panel) in a separate part of this Opinion (see Appendix A of the BIOHAZ Panel)

A **third group** of chemical substances that may occur in edible tissues of poultry are contaminants that may enter the animal's body mainly via feed and more exceptionally by drinking water, inhalation or direct (skin) contact. Feed materials can contain a broad variety of undesirable substances comprising persistent environmental pollutants, toxic metals and other elements as well as natural toxins, such as toxic secondary plant metabolites and fungal toxins (mycotoxins). Feed producers have to act in compliance with Commission Directive 2002/32/EC,[34] listing the undesirable substances in feed and feed materials and presenting maximum content in feed materials or compound feeds. In a recent re-assessment of these undesirable substances in animal feeds, the EFSA Panel on

[32] Regulation (EC) No 470/2009 of the European Parliament and of the Council of 6 May 2009 laying down Community procedures for the establishment of residue limits of pharmacologically active substances in foodstuffs of animal origin, repealing Council Regulation (EEC) No 2377/90 and amending Directive 2001/82/EC of the European Parliament and of the Council and Regulation (EC) No 726/2004 of the European Parliament and of the Council. OJ L 152, 16.6.2009, p. 11-22.

[33] Regulation (EC) No 1831/2003 of the European Parliament and of the Council of 22 September 2003 on additives for use in animal nutrition. OJ L 268, 18.10.2003, p. 29-43.

[34] Directive 2002/32/EC of the European Parliament and of the Council of 7 May 2002 on undesirable substances in animal feed. OJ L 140, 30.5.2002, p. 10-21.

Contaminants in the Food Chain (CONTAM Panel) re-evaluated the risk related to exposure to these substances for animals. Special attention was given to toxic compounds that accumulate or persist in edible tissues including meat or are directly excreted into milk and eggs. Where appropriate, suggestions for addition of amendments of maximum levels for food of animal origin (meat, milk, eggs) were made resulting in amendments of Council Directive 2002/32/EC[34] and/or Commission Regulation (EC) No 1881/2006[29] (cross-contamination of feed batches with licensed feed additives).

2.2.1. Statutory limits

Article 2 of Council Regulation (EEC) No 315/93[35] of 8 February 1993 laying down Community procedures for contaminants in food stipulates that, where necessary, maximum tolerances for specific contaminants shall be established. Subsequently, a number of maximum levels for various contaminants in different foodstuffs were laid down in the Annex of Commission Regulation (EC) No. 1881/2006[29] of 19 December 2006 setting maximum levels (MLs) for certain contaminants in foodstuffs, last amended by Commission Regulation (EU) No 1259/2011.[36] Regarding poultry, maximum levels were established for lead, cadmium, dioxins, the sum of dioxins and dioxin-like PCBs (DL-PCBs) and for the sum of six non dioxin-like PCBs (NDL-PCBs).

Table 3: Contaminants currently regulated in Regulation (EC) No 1881/2006[37] in poultry.

Contaminant	MLs	Health-based guidance values/MOE approach	Assessments: Reference
Dioxins and dioxin-like PCBs	Dioxins: Meat, fat and meat products: 1.75 pg WHO-TEQ/g fat Liver and derived products: 4.5 pg WHO-TEQ/g fat Dioxins + DL-PCBs: Meat, fat and meat products: 3.0 pg WHO-TEQ/g fat Liver and derived products: 10.0 pg WHO-TEQ/g fat	TWI: 14 pg/WHO-TEQ/kg b.w.	SCF, 2001
Non dioxin-like PCBs (sum of PCBs 28, 52, 101, 138, 153 and 180)	Meat, fat and meat products: 40 ng/g fat Liver and derived products: 40 ng/g fat	MOE approach	EFSA, 2005
Cadmium	Meat: 0.050 mg/kg wet weight Liver: 0.50 mg/kg wet weight Kidney: 1.0 mg/kg wet weight	TWI: 2.5 µg/kg b.w.	EFSA, 2009, 2011c
Lead	Meat: 0.10 mg/kg wet weight Offal: 0.50 mg/kg wet weight	MOE approach	EFSA, 2010b

ML: maximum level; b.w.: body weight; MOE: margin of exposure; TEQ: toxic equivalent; TWI: tolerable weekly intake.

Recently, the MLs for dioxins and the sum of dioxins and DL-PCBs in food were reviewed taking into account new data, and amended accordingly. The revised MLs above apply from 1 January 2012. In contrast to the former values, the revised MLs are expressed as TEQs using the WHO-TEFs$_{2005}$ for human risk assessment based on the conclusions of the World Health Organization (WHO) -

[35] Council Regulation (EEC) No 315/93 of 8 February 1993 laying down Community procedures for contaminants in food. OJ L 37, 13.2.1993, p. 1-3.

[36] Commission Regulation (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non dioxin-like PCBs in foodstuffs. OJ L 320, 3.12.2011, p. 18-23.

[37] The given data refer to the provisions in Regulation (EC) No 1881/2006 and are often based on Opinions of the previous Scientific Committee on Food (SCF), and assessment by the Joint FAO/WHO Expert Committee on Food Additievs (JECFA) or in some cases on recent EFSA scientific outputs.

International Programme on Chemical Safety (IPCS) expert meeting which was held in Geneva in June 2005 (van den Berg et al., 2006).

In addition to dioxins and the sum of dioxins and DL-PCBs, the amended Regulation also sets MLs for the sum of the six indicator-PCBs identified by the CONTAM Panel (PCB-28, -52, -101, -138, -153, and -180) (EFSA, 2005) for various kinds of foodstuffs following the same food categorization as for dioxins and the sum of dioxins and DL-PCBs.

As an early warning tool, the European Commission has set action levels for dioxins and DL-PCBs in food through Commission Recommendation 2011/516/EC.[38] Due to the fact that their sources are generally different, separate action levels for dioxins and DL-PCBs were established. The action levels for meat and meat products of poultry are 1.25 pg WHO-TEQ/g fat for dioxins and 0.75 pg WHO-TEQ/g fat for DL-PCBs.

In cases where levels of dioxins and/or DL-PCBs in excess of the action levels are found, it is recommended that MSs, in co-operation with food business operators, initiate investigations to identify the source of contamination, take measures to reduce or eliminate the source of contamination and check for the presence of NDL-PCBs.

2.3. Ranking of the substances of potential concern

A multi-step approach was used for ranking the potential concern of the three groups of substances that are presented in Sections 2.1 and 2.2. These include:

- Evaluation of the outcomes of the NRCPs indicating the number of results that are non-compliant with the current legislation.
- Evaluation of the likelihood that specific residues or contaminants, including emerging substances, may be present in poultry carcasses.
- Consideration of the toxicological profile for each chemical substance.

2.3.1. Outcome of the National Residue Control Plans (NRCPs) within the EU

Data from the NRCPs are published annually and these data were considered as the first step for hazard ranking. Aggregated data regarding the outcome of the NRCPs for targeted sampling of poultry from 2005 to 2010 are presented in Tables 4-6. The grouping follows Council Directive 96/23/EC.[8] Data reported in 2005 were from the then 25 EU MSs whereas for the subsequent years (2006 - 2010) data have been gathered from 27 EU MSs, following the accession of Romania and Bulgaria to the EU.

Results from suspect sampling are not included, as these results are considered not to be representative of the actual occurrence of chemicals. As stated above, suspect sampling arises as (i) a follow-up to the occurrence of a non-compliant result and/or (ii) on suspicion of illegal treatment at any stage of the food chain and/or (iii) on suspicion of non-compliance with the withdrawal periods for authorised veterinary medicinal products (Articles 5, 11 and 24 of Directive 96/23/EC,[8] respectively).

A non-compliant result refers to an analytical result exceeding the permitted limits or, in the case of prohibited substances, any measured level with sufficient statistical certainty that it can be used for legal purposes.[39] As mentioned above, for veterinary medicinal products, MRLs are laid down in Commission Regulation (EU) No 37/2010.[27] For pesticides, MRLs are laid down in Regulation (EC)

[38] Commission Recommendation of 23 August 2011 on the reduction of the presence of dioxins, furans and PCBs in feed and food. OJ L 218, 24.08.2011, p. 23-25.

[39] As laid down in Article 6 of Decision 2002/657/EC, the result of an analysis shall be considered non-compliant if the decision limit of the confirmatory method for the analyte is exceeded. Decision limit is defined in Article 6(3) as the lowest concentration at which the method can confirm with a defined statistical certainty (99 % for substances for which no permitted limit has been established, and 95 % for all other substances) that the particular analyte is present.

No 396/2005.[28] MLs for contaminants are laid down in Commission Regulation (EC) No 1881/2006.[29] National tolerance levels are applied by individual MSs for contaminants where no EU maximum levels have been established. For certain substances that are not licensed within the EU, such as chloramphenicol, nitrofurans and their metabolites, medroxyprogesterone acetate and (leuco-)malachite green. Minimum Required Performance Limits (MRPLs) have been established (Commission Decision 2002/657/EC[40]) to make results of residue testing comparable between laboratories and MSs, and these MRPLs were used in the reporting system.

It should be noted that information on the number of total analyses performed for an individual substance is only transmitted by those MSs that were reporting at least one non-compliant result for that substance. Therefore, it is not possible to extract from the data supplied, complete information on the individual substances from each sub-group tested nor the number of samples tested for an individual substance where no non-compliant results is reported.

In addition, in some cases the same samples were analysed for different substance groups/sub-groups and therefore the number of substance groups/sub-groups tested is higher than the total number of samples collected from poultry. It is to be noted that there is a lack of harmonisation regarding details provided on non-compliant results for the NRCP from MSs. This hampers the interpretation and the evaluation of these data. Moreover, no information is available on the nature of the positive samples (i.e. whether this refers to muscle, liver, kidney or skin/fat samples) and these results give no indication of the actual measured concentrations of residues or contaminants. As a result, in the absence of substance-specific information and the actual concentration of a residue or contaminant measured, these data do not allow an assessment of consumer exposure.

[40] Commission Decision of 12 August 2002 implementing Council Directive 96/23/EC concerning the performance of analytical methods and the interpretation of results (2002/657/EC). OJ L 221, 17.8.2002, p. 8-36.

Table 4: Non-compliant (NC) results[(a)] for prohibited substances (Group A) in poultry reported from National Residue Control Plans (NRCPs), 2005-2010 (targeted sampling). Information extracted from the reports published by the European Commission[(b)]. In brackets: number of samples taken at farm/number of samples taken at slaughterhouse.

Sub-group	Substance	2010 (EU27)		2009 (EU27)		2008 (EU27)		2007 (EU27)		2006 (EU27)		2005 (EU25)	
		NC	Total	NC	Total	NC	Total	NC	Total	NC	Total	NC	Total
A1 Stilbenes		0	3270 (718/2552)	0	3289 (724/2565)	0	2861 (624/2237)	0	3241 (677/2564)	0	3095 (605/2490)	0	3118 (647/2471)
A2 Thyreostats		0	934 (163/771)	0	951 (160/791)	0	913 (177/736)	0	910 (253/657)	0	1022 (263/759)	0	1219 (305/914)
A3 Steroids		1 (0/1)	4055 (854/3201)	1 (0/1)	4038 (875/3161)	2 (0/2)	3610 (827/2783)	2 (0/2)	3858 (765/3093)	1 (0/1)	3912 (758/3154)	1 (0/1)	3652 (775/2877)
	Estradiol-17-Beta	0		1(0/1)		2(0/2)		1(0/1)		1(0/1)		1(0/1)	
	Ethinylestradiol	0		0		0		0		0		0	
	Nandrolone	1 (0/1)		0		0		1(0/1)		0		0	
A4 Resorcylic acid lactones (RALs)		0	3239 (602/2637)	0	3307 (713/2597)	0	2742 (609/2133)	0	3199 (670/2529)	0	3112 (614/2498)	0	3077 (634/2443)
A5 Beta-Agonists		0	5596 (2008/3588)	0	5502 (1887/3615)	0	4613 (1550/3063)	3 (0/3)	5544 (1802/3742)	0	5,594 (1748/3846)	0	6302 (2010/4292)
	Clenbuterol	0		0				3(0/3)		0		0	
A6 Annex IV compounds		7 (4/3)	16823 (4273/12550)	12 (1/11)	15995 (3761/12234)	14 (2/12)	13400 (3153/10247)	13 (4/9)	16552 (3054/13498)	15 (2/13)	16888 (3919/12969)	19 (5/14)	14944 (3683/11261
	Chloramphenicol	3 (3/0)		9(1/8)		5(2/3)		7(2/5)		11(2/9)		11(4/7)	
	Furazolidone/AOZ	2 (0/2)		2(0/2)		1(0/1)		0		1(0/1)		1(0/1)	
	Furaltadone/AMOZ	0		0		3(0/3)		1(1/0)		1(0/1)		1(0/1)	
	Nitrofurantoin/AHD	0		0		0		0		0		4(0/4)	
	Nitrofurazone/SEM	1 (1/0)		1(0/1)		0		0		0		0	
	Nitrofurans group	0		0		0		0		1(0/1)		0	
	Dimetridazole	0		0		0		0		0		1(1/0)	
	Metronidazole	1(0/1)		0		2(0/2)		0		0		1(0/1)	
	Ronidazole	0		0		1(0/1)		1(1/0)		1(0/1)		0	
	Nitroimidazoles group	0		0		2(0/2)		4(0/4)		0		0	

(a): One sample can be non-compliant for more than one substance.
(b): Published at http://ec.europa.eu/food/food/chemicalsafety/residues/control_en.htm.

Table 5: Non-compliant (NC) results[(a)] for Veterinary Medicinal Products (Antibacterial substances and other veterinary drugs, Groups B1 and B2) in poultry reported from National Residue Control Plans (NRCPs), 2005-2010 (targeted sampling). Information extracted from the reports published by the European Commission.[(b)] In brackets: number of samples taken at farm/number of samples taken at slaughterhouse.

Sub-group / Substance	2010 (EU27)		2009 (EU27)		2008 (EU27)		2007 (EU27)		2006 (EU27)		2005 (EU25)	
	NC	Total	NC	Total	NC	Total	NC	Total	NC	Total	NC	Total
B1 Antibacterials	20 (0/20)	16968 (528/16440)	35 (6/29)	17942 (976/16966)	34 (16/18)	15096 (708/14388)	33 (5/28)	16954 (480/16474)	23 (5/18)	16352 (569/15783)	35 (17/18)	19897 (1074/18823)
Antibacterials (un-specified)	0		4 (0/4)		7 (0/7)		7 (0/7)		8 (0/8)		3 (0/3)	
Fluoroquinolones	0		0		0		0		0		0	
Ciprofloxacin	0		2 (0/2)		0		1 (0/1)		0		0	
Difloxacin	1 (0/1)		0		0		0		0		0	
Enrofloxacin	2 (0/2)		8 (0/8)		1 (0/1)		14(3/11)		6 (3/3)		7 (1/6)	
Flumequine	0		0		0		0		0		1 (0/1)	
Quinolones	0		0		0		0		0		0	
Oxolinic acid	1(0/1)		0		0		0		0		0	
Sarafloxacin	1(0/1)		0		0		0		0		0	
Tetracyclines	0		0		0		0		3 (0/3)		0	
Chlortetracycline	0		3 (0/3)		1 (0/1)		1 (1/0)		1 (0/1)		2 (1/1)	
Doxycycline	14 (0/14)		12 (4/8)		18 (10/8)		3 (0/3)		4 (2/2)		6 (0/6)	
Oxytetracycline	0		5 (2/3)		1(1/0)		2 (1/1)		0		11(10/1)	
Tetracycline	0		0		0		1 (0/1)		0		0	
Sulfonamides	0		0		4 (4/0)		0		0		0	
Sulfachlorpyridazine	0		0		0		1 (0/1)		0		0	
Sulfadiazine	0		0		0		0		0		2 (1/1)	
Sulfadimethoxine	1(0/1)		0		0		0		0		0	
Sulfadimidine	0		1 (0/1)		0		1 (0/1)		0		2 (0/2)	
Sulfaquinoxaline	0		0		0		2 (0/2)		1 (0/1)		0	
Sulfathiazole	0		0		2 (1/1)		0		0		0	
Tylosin	0		0		0		0		0		1 (1/0)	
B2a Anthelmintics	0	2997 (40/2957)	0	2989 (3/2986)	1 (0/1)	1671 (2/1669)	0	3170 (4/3166)	2 (0/2)	3176 (14/3162)	0	2706 (16/2690)
Ivermectin	0		0		1 (0/1)		0		0		0	
Oxfendazole	0		0		0		0		2 (0/2)		0	
B2b Anticoccidials	73 (0/73)	7640 (1048/6592)	131 (0/131)	6390 (1039/5351)	180 (0/180)	5991 (803/5188)	128 (0/128)	6241 (807/5434)	109 (2/107)	5557 (798/4759)	75 (0/75)	6125 (785/5340)

Table 5: Continued.

Sub-group	Substance	2010 (EU27) NC	2010 (EU27) Total	2009 (EU27) NC	2009 (EU27) Total	2008 (EU27) NC	2008 (EU27) Total	2007 (EU27) NC	2007 (EU27) Total	2006 (EU27) NC	2006 (EU27) Total	2005 (EU25) NC	2005 (EU25) Total
	Non-ionophores												
	Amprolium	0		0		0		0		0		1 (0/1)	
	Clopidol	0		0		1 (0/1)		3 (0/3)		0		0	
	Decoquinate	2 (0/2)		0		0		0		0		0	
	Diclazuril	3 (0/3)		0		1 (0/1)		6 (0/6)		6 (0/6)		11 (0/11)	
	Nicarbazin [(c)]	46 (0/46)		106 (0/106)		145(0/145)		96 (0/96)		99 (2/97)		51(0/51)	
	Toltrazurilsulfone	1 (0/1)		0		0		0		0		0	
	Robenidine	1 (0/1)		0		5 (0/5)		2 (0/2)		1 (0/1)		0	
	Ionophores												
	Lasalocid	8 (0/8)		10 0/10)		9 (0/9)		6 (0/6)		3 (0/3)		6 (0/6)	
	Maduramicin	5 (0/5)		8 (0/8)		15 (0/15)		10 (0/10)		0		1 (0/1)	
	Monensin	0		2 (0/2)		0		1 (0/1)		0		3 (0/3)	
	Narasin	0		0		1 (0/1)		0		0		0	
	Salinomycin	7 (0/7)		5 (0/5)		3 (0/3)		4 (0/4)		1 (0/1)		2 (0/2)	
B2c	**Carbamates and pyrethroids**	0	1845 (14/1831)	0	1561 (16/1545)	0	1334 (7/1327)	0	1647 (4/1643)	0	1670 (12/1658)	0	1551 (26/1525)
B2d	**Sedatives**	0	49 (0/49)	0	14 (0/14)	0	38 (0/38)	0	17 (0/17)	0	58 (0/58)	0	21 (0/21)
B2e	**Non-steroidal anti-inflammatory drugs (NSAIDs)**	1 (0/1)	734 (29/705)	3 (0/3)	655 (26/629)	8 (0/8)	789 (2/787)	2 (0/2)	659 (0/659)	2 (0/2)	646 (5/641)	4 (0/4)	712 (14/698)
	Antipyrin-4-Methylamino	0		0		2 (0/2)		0		0		0	
	Carprofen	0		0		1 (0/1)		0		0		0	
	Diclofen (diclofenac)	0		1(0/1)		0		0		0		0	
	Flunixin	0		0		1 (0/1)		2 (0/2)		0		2 (0/2)	
	Ketoprofen	1 (0/1)		2(0/2)		2 (0/2)		0		0		0	
	Meloxicam	0		0		1 (0/1)		0		0		0	
	Sodium salicylate	0		0		1 (0/1)		0		2 (0/2)		2 (0/2)	
B2f	**Other**	1 (0/1)	650 (332/318)	1 (0/1)	505 (308/197)	0	465 (220/245)	0	466 (379/87)	1 (0/1)	587 (216/371)	2 (0/2)	498 (348/150)
	Olaquindox	1 (0/1)		1 (0/1)		0		0		1 (0/1)		2 (0/2)	

[(a):] One sample can be non-compliant for more than one substance.
[(b):] Published at http://ec.europa.eu/food/food/chemicalsafety/residues/control_en.htm.
[(c):] Prior to October 2010 (Commission Regulation (EU) 875/2010[41]), there was no EU Maximum Residue Limit established for nicarbazin residues in broiler tissues and, therefore, results reported as non-compliant refer to the tolerance levels applied in the respective MS.

[41] Commission Regulation (EU) No 875/2010 of 5 October 2010 concerning the authorisation for 10 years of an additive in feedingstuffs. OJ L 263, 6.10.2010, p. 4-6.

Table 6: Non-compliant (NC) results[(a)] for other substances and environmental contaminants (Group B3) in poultry reported from National Residue Control Plans (NRCPs), 2005-2010 (targeted sampling). Information extracted from the reports published by the European Commission[(b)]. In brackets: number of samples taken at farm/number of samples taken at slaughterhouse.

Sub-group	Substance	2010 (EU27)		2009 (EU27)		2008 (EU27)		2007 (EU27)		2006 (EU27)		2005 (EU25)	
		NC	Total	NC	Total	NC	Total	NC	Total	NC	Total	NC	Total
B3a Organochlorine compounds		0	2215 (21/2194)	3 (0/3)	2559 (61/2498)	0	2336 (55/2281)	1 (0/1)	2320 (80/2240)	5 (1/4)	2553 (94/2459)	0	2878 (102/2776)
	Dioxins	0		2 (0/2)		0		1 (0/1)		1 (0/1)		0	
	Non-dioxin-like PCBs	0		0		0		0		1 (1/0)		0	
	pp'-DDE	0		0		0		0		3 (0/3)		0	
	gamma-HCH (HCH, Lindane)	0		1 (0/1)		0		0		0		0	
B3b Organophosphorus compounds		0	218 (6/212)	0	279 (52/227)	0	169 (43/226)	0	235 (63/172)	0	386 (60/326)	0	261 (56/205)
B3c Chemical elements		2 (0/2)	1987 (31/1956)	2 (0/2)	1834 (30/1804)	5 (0/5)	1955 (10/1945)	5 (0/5)	2037 (18/2019)	21 (1/20)	1956/ (41/1915)	17 (0/17)	2059 (9/2050)
	Arsenic (As)	1 (0/1)		0		0		0		0		0	
	Cadmium (Cd)	1 (0/1)		1 (0/1)		4 (0/4)		5		17(1/16)		11(0/11)	
	Lead (Pb)	0		1 (0/1)		0		0		4 (0/4)		6 (0/6)	
	Mercury (Hg)	0		0		1 (0/1)		0		0		0	
B3d Mycotoxins		0	708 (184/524)	0	720 (166/554)	0	824 (129/695)	0	856 (173/683)	0	974 (222/752)	1 (1/0)	884 (159/725)
	Aflatoxin B1	0		0		0		0		0		1 (1/0)	
B3e Dyes		0	0	0	0	0	1 (0/1)	0	0	0	0	0	2 (0/2)
B3f Other		1 (1/0)	215 (1/214)	0	427 (38/389)	0	352 (11/341)	0	205 (2/203)	1 (1/0)	254 (4/250)	0	217 (6/211)
	Nicotine	1 (1/0)		0		0		0		1 (1/0)		0	

(a): One sample can be non-compliant for more than one substance.
(b): Published at http://ec.europa.eu/food/food/chemicalsafety/residues/control_en.htm.
PCB: polychlorinated biphenyls; DDE: dichlorodiphenyldichloroethylene; HCH: hexachlorocyclohexanes.

In spite of the limitations highlighted above, an overall assessment of these data indicates that the percentage of non-compliant results is of a low order of magnitude as compared to the total number of samples tested. For example 1 053 (0.27 %) of the 394 746 samples analysed in the EU for the NRCPs during the period 2005-2010 were non-compliant for one or more of the substance groups listed in Annex I of Directive 96/23/EC.[8] Further details are presented in Table 7.

Table 7: Overview of non-compliant (NC) results[(a)] as reported in the National Residue Control Plans (NRCPs)[(b)] for the period 2005-2010 in the EU.

Year	Group A	Group B1-B2	Group B3	Total
Total samples analysed	188 346	174 796	31 604	394 746
Farm level	45 588	11 550	1 589	58 727
Slaughterhouse level	142 758	163 246	30 015	336 019
Total NC results	91	896	66	1 053
Farm level	18	54	6	78
Slaughterhouse level	73	842	60	975

(a): One sample can be non-compliant for more than one substance.
(b): Published at http://ec.europa.eu/food/food/chemicalsafety/residues/control_en.htm.

2.3.2. Analysis of the data

It should be noted that of the total number of samples taken for analysis during the period 2005-2010, 14.8 % were taken at farm level while the remaining 85.2 % were taken at slaughterhouse level. No information on poultry species is available. Results indicate that:

- 0.27 % of the total results were non-compliant for one or more substances, with 0.05 %, 0.51 % and 0.21 % being non-compliant for Group A, Group B1/B2 and Group B3 substances, respectively.
- 0.13 % of all results for samples taken at farm level were non-compliant for one or more substances, with 0.04 %, 0.47 % and 0.38 % being non-compliant for Group A, Group B1/B2 and Group B3 substances, respectively.
- 0.29 % of all results for samples taken at slaughterhouse level were non-compliant for one or more substances, with 0.05 %, 0.52 % and 0.20 % being non-compliant for Group A, Group B1/B2 and Group B3 substances, respectively.

The highest overall proportion of non-compliant results (0.51 %) was for Group B1/B2 substances, VMPs, representing largely exceedances of the MRLs specified for these substances. The lowest proportion of non-compliant results overall (0.05 %) were for Group A substances, prohibited substances, representing largely illicit use of these substances. Results of samples tested for Group B3 substances, contaminants, were intermediate overall (0.21 %), representing exceedances of the MRLs/MLs specified for these substances.

An analysis of the results for sampling at farm level compared to slaughterhouse level indicates that for VMPs (Group B1/B2) there is little difference in the rate of non-compliant results determined. However, sampling at slaughterhouse level may be more appropriate for identifying non-compliant results for VMPs, based on compliance with or exceedance of the specified MRLs in edible tissues.

In the case of prohibited substances (Group A), the rate of non-compliant results determined for sampling at farm level is broadly similar to the rate of non-compliant results determined for sampling at slaughterhouse level. However, sampling exclusively at slaughterhouse level for prohibited substances is not entirely appropriate as farm level sampling is an integral component of the system for controlling illicit use of prohibited substances.

In the case of contaminants (Group B3), the rate of non-compliant results determined for sampling at farm level is higher than for sampling at slaughterhouse level. However, it is not possible to draw any firm conclusions regarding the efficiency of sampling point, in terms of detecting non-compliant results, from the data for contaminants due to the low number of samples taken at farm level and the low number of non-compliant results found. Furthermore, sampling for Group B3 substances is more appropriate, generally, at slaughterhouse level where identification of non-compliant results, based on compliance with or exceedance of specified MRLs/MLs in edible tissues, may be made.

It should be noted also that a direct comparison of data from the NRCPs over the years is not entirely appropriate as the test methods used and the number of samples tested for an individual residue varied between MSs. In addition, there are ongoing improvements in analytical methods, in terms of method sensitivity, accuracy and scope (i.e. number of substances covered by the method), which affects inter-year and inter-country comparisons. Therefore, the cumulative data from the NRCPs provide only a broad indication of the prevalence and nature of the non-compliant results.

In conclusion, this compilation of data clearly indicates the low prevalence of abiotic hazards (residues and contaminants) in poultry. Only approximately 0.27 % of the total number of results was non-compliant for one or more substances listed in Annex I of Directive 96/23/EC.[8] It was concluded that chemical substances in poultry are unlikely to pose an immediate or acute health risk for consumers. Consequently, potentially higher exposure of consumers to these residues from poultry or poultry products takes place only incidentally, as a result of mistakes or non-compliance with known and regulated procedures. However, in the absence of substance-specific information, such as the tissues used for residue analysis and the actual concentration of a residue or contaminant measured, these data do not allow a reliable assessment of consumer exposure.

2.4. Criteria used for the evaluation of the likelihood of the occurrence of residues or contaminants[42] in poultry meat taking into account the toxicological profile

Independent from the occurrence data as reported from the NRCPs, each substance or group of chemical substances that may enter the food chain was also evaluated for the likelihood that potentially toxic or undesirable substances might occur in poultry carcasses.

For prohibited substances and VMPs/feed additives, the following criteria were used:

- the likelihood of the substance(s) being used in an illicit or non-compliant way in poultry (suitability for poultry production; commercial advantages);
- the potential availability of the substance(s) for illicit or non-compliant usage in poultry production (allowed usage in Third Countries; availability in suitable form for use in poultry; non-authorised supply chain availability ("black market"); common or rare usage as a commercial licensed product);
- the likelihood of the substance(s) occurring as residue(s) in edible tissues of poultry based on the kinetic data (pharmacokinetic and withdrawal period data; persistence characteristics; special residue issues – e.g. bound residues of nitrofurans);
- toxicological profile and nature of hazard and the relative contribution of residues in poultry and poultry products to dietary human exposure.

For contaminants, the following criteria were considered:

- the prevalence (where available) of occurrence of the substances in animal feeds in the EU;
- the level and duration of exposure, tissue distribution and deposition including accumulation in edible tissues of poultry;
- toxicological profile and nature of hazard and the relative contribution of residues in poultry and poultry products to dietary human exposure.

[42] Note that residues comprise both prohibited substances and veterinary medicinal products/feed additives. Contaminants refer to any substance not intentionally added to feed or food as defined in Council Regulation (EEC) No. 315/93.

2.4.1. General flow chart

Considering the above mentioned criteria, a flow-chart approach was used for ranking of the chemical residues and contaminants of potential concern. The outcome of the NRCPs (indicating the number of non-compliant results), the evaluation of the likelihood that residues of substances of potential concern can occur in poultry and the toxicological profile of each substance were considered in the development of the general flow-chart, as presented in Figure 1.

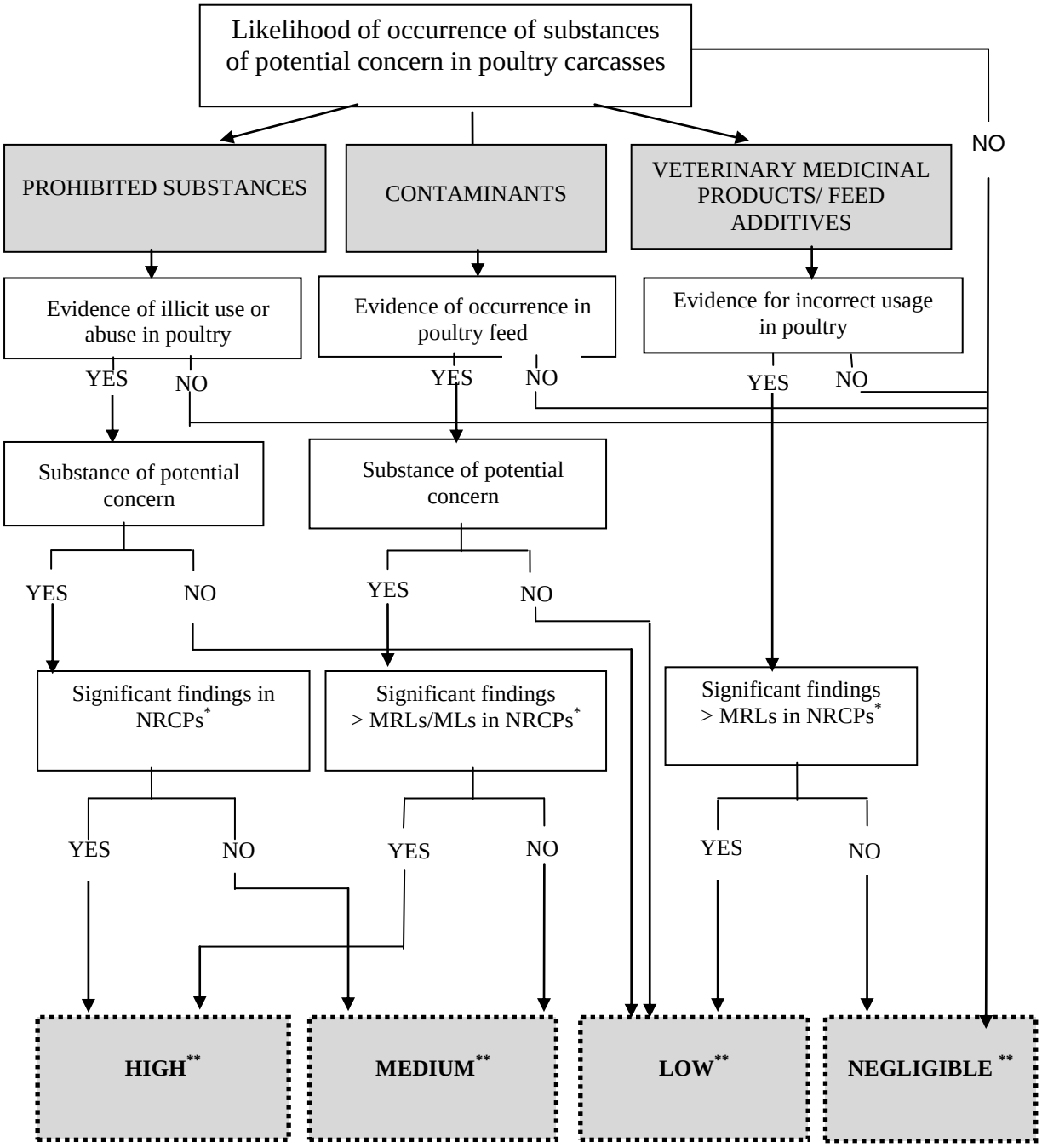

Figure 3: General flow-chart used for the ranking of residues and contaminants of potential concern that can be detected in poultry carcasses.

* NRCPs (National Residue Control Plans).
**see definitions provided in next Section 2.4.2.

2.4.2. Outcome of the ranking of residues and contaminants of potential concern that can occur in poultry carcasses

Four categories were established resulting from the application of the general flow-chart:

Category 1 - negligible potential concern:

Substance irrelevant in poultry production (no known use at any stage of production); no evidence for illicit use or abuse in poultry; not or very seldom associated with exceedances in MRL levels in NRCPs; no evidence of occurrence as a contaminant in poultry feeds.

Category 2 - low potential concern:

Veterinary medicinal products/feed additives which have an application in poultry production, residues above MRLs are found in control plans, but substances are of low toxicological concern. Contaminants and prohibited substances with a toxicological profile that does not include specific hazards following accidental exposure of consumers, and which are generally not found or are not found above MLs in poultry.

Category 3 - medium potential concern:

Contaminants and prohibited substances to which poultry are known to be exposed and/or history of misuse, with a toxicological profile that does not entirely exclude specific hazards following accidental exposure of consumers; evidence for residues of prohibited substances being found in poultry; contaminants generally not found in concentrations above the MRL/ML values in major edible tissues of poultry.

Category 4 - high potential concern:

Contaminants and prohibited substances to which poultry are known to be exposed and with a history of misuse, with a distinct toxicological profile comprising a potential concern to consumers; evidence for ongoing occurrence of residues of prohibited substances in poultry; evidence for ongoing occurrence and exposure of poultry to feed contaminants.

2.4.2.1. Substances classified in the category of high potential concern

2.4.2.1.1. Contaminants: Dioxins and dioxin-like polychlorinated biphenyls (DL-PCBs)

In the high potential concern category are dioxins and DL-PCBs as occurrence data from literature and control plans show a number of incidents due to contamination of feed, such as illegal disposal of dioxin and DL-PCBs containing waste materials into feed components and an impact of impurities of litter on the contamination of poultry and poultry derived products. In addition, exposure of out-door poultry and/or poultry reared on organic farms, if kept on contaminated soils, may contribute to the overall incidence of carcass contamination.

(a) Dioxins

Dioxins are persistent organochlorine contaminants which are not produced intentionally, have no targeted use, but are formed as unwanted and often unavoidable by-products in a number of thermal and industrial processes. Because of their low water solubility but high lipophilic properties they bioaccumulate in the food chain and are stored in fatty tissues of animals and humans. The major pathway to human dioxin exposure is via consumption of food of animal origin which generally contributes more than 80 % of the total daily dioxin intake (EFSA, 2010b). A number of dioxin incidents in the past 15 years were caused by contamination of feed with dioxins. Recently, in 2010/2011, contaminated fatty acids originating from the production of biodiesel from used cooking oils were illegally introduced into the feed chain. As a consequence, more than 5 000 farms were temporarily blocked. Mainly laying hens, turkeys and pigs were affected. All the incidents were caused by grossly negligent or criminal actions and led to widespread contamination of feed and sometimes to high dioxin levels in the animals and the foodstuffs produced from them.

Poultry may be exposed to pentachlorophenol (PCP) present in bedding materials derived from treated timber. As a result, PCP and its contaminants, such as dioxins or degradation products may be present in the tissues as well as in the eggs (Brambilla et al., 2009).

Regarding the toxicological profile, it is noted that based on extrapolations from animal studies and human epidemiological data (SCF, 2001) there is sufficient evidence that dioxins at higher concentrations may cause cancer in several organs in humans. However, these effects are apparent only after prolonged exposure. Dioxins have a long half-life and are accumulated in various tissues. The finding of elevated levels in food are of public health concern as human dietary exposure to dioxins is considered to arise primarily from food of animal origin. The available data indicate that a substantial part of the European population is in the range of or already exceeding the tolerable weekly intake for dioxin (and DL-PCBs). Current normal background exposure from diverse sources is not expected to affect human health on average. However, due to the high toxic potential of this class of compounds, efforts need to be undertaken to reduce exposure where possible.

In their report "Results of the monitoring of dioxin levels in food and feed", EFSA states that 8.5 % of meat and products of poultry exceed the action level and 4.3 % exceed the maximum level (EFSA, 2010b). For poultry fat, the respective proportions are each 4.5 %. Higher percentages were reported for laying hens and egg products with values of 11.3 % and 5.2 %, respectively. However, it has to be acknowledged that some of the samples included in this report may be the result of multiple targeted sampling during contamination incidences and therefore do not necessarily reflect the representative dioxin content in poultry.

In summary, based on the high toxicity and the low maximum levels set for poultry and poultry products (Table 3), and considering that food of animal origin contributes significantly (>80 %) to human exposure, dioxins have been ranked into the category of substances of high potential concern.

(b) DL-PCBs

In contrast to dioxins, PCBs had widespread use in numerous industrial applications, generally in the form of complex technical mixtures. Due to their physico-chemical properties, such as non-flammability, chemical stability, high boiling point, low heat conductivity and high dielectric constants, PCBs were widely used in industrial and commercial closed and open applications. They were produced for over four decades, from 1929 onwards until they were banned, with an estimated total world production of 1.2-1.5 million tonnes. According to Council Directive 96/59/EC[43] MSs should have taken the necessary measures to ensure that used PCBs were disposed off and equipment containing PCBs were decontaminated or disposed off at the latest by the end of 2010. Earlier experience has shown that illegal practices of PCBs disposal may occur resulting in considerable contamination of animals and foodstuffs of animal origin.

Based on structural characteristics and toxicological effects, PCBs can be divided into two groups. One group consists of 12 congeners that can easily adopt a coplanar structure and have the ability to bind to the Ah-receptor, thus showing toxicological properties similar to dioxins (effects on liver, thyroid, immune function, reproduction and behaviour). This group of PCBs is therefore called "dioxin-like PCBs" (DL-PCBs). The other PCBs do not show dioxin-like toxicity and have a different toxicological profile, in particular with respect to effects on the developing nervous system and neurotransmitter function. This group of PCBs is called "non dioxin-like PCBs" (NDL-PCBs) (see below).

As DL-PCBs show a comparable lipophilicity, bioaccumulation, toxicity and mode of action as dioxins (EFSA, 2005), these two groups of environmental contaminants are regulated together in European legislation and are considered together in risk assessments. Based on the high toxicity,

[43] Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT). OJ L 243, 24.9.1996, p. 31-35.

widespread use and potential for improper disposal practices of technical PCB mixtures, DL-PCBs are added to the category of substances of high potential concern.

2.4.2.1.2. Prohibited substances: chloramphenicol, nitroimidazoles and nitrofurans

(a) Chloramphenicol

Chloramphenicol is an antibiotic substance with broad spectrum activity which has been widely used in human and veterinary medicine. Chloramphenicol may induce blood dyscrasias in humans, particularly bone marrow aplasia, or aplastic anaemia, which may be fatal. The mechanism of induction of aplastic anaemia is not fully understood (Watson, 2004). Although the incidence of aplastic anaemia associated with exposure to chloramphenicol is apparently very low, no threshold level could be defined (EMEA, 2009a). In addition, several studies suggest that chloramphenicol and some of its metabolites are genotoxic (FAO/WHO, 1988, 2004; EMEA, 2009a). Therefore, no no-observed-adverse-effect level (NOAEL) and subsequently no ADI could be established. Based on these evaluations and in the absence of additional toxicological investigations, chloramphenicol was added to Annex II of Commission Regulation (EU) No. 37/2010[27] (previously Annex IV of Council Regulation (EEC) No. 2377/90[31]).

Despite that fact that the use of chloramphenicol is not permitted in food-producing animals, residues have been regularly found in poultry in the residue monitoring programme. Indeed, a total of 46 of the 91 non-compliant results reported during the period 2005 to 2010 for Group A (compounds included in Annex II Reg. 37/2010[27]27) concerned chloramphenicol. These positive results for chloramphenicol were found in various MSs, suggesting that chloramphenicol is still used in poultry in Europe. The proven clinical efficacy of chloramphenicol as a broad spectrum antibiotic and the fact that it is still licensed for use in many Third Countries may explain the relatively high number of non-compliant samples.

Considering that currently no ADI is established, and therefore the use of chloramphenicol is prohibited in poultry, chloramphenicol is added to the category of substances of high potential concern requiring residue monitoring.

(b) Nitroimidazoles

Nitroimidazoles[44] have historically been legally available and used as VMPs for poultry in the EU, but were banned for this purpose because no ADI could be established. The nitroimidazoles dimetridazole, metronidazole and ronidazole, are a group of drugs having antibacterial, antiprotozoal and anticoccidial properties. Metronidazole and ronidazole are effective against trichomonads and dimetridazole and ronidazole are effective against histomoniasis in poultry, while all three drugs are active against obligatory anaerobic bacteria. Nitroimidazoles have been used primarily to prevent and treat the diseases histomoniasis and trichomoniasis in turkeys, pigeons and game birds as no other approved veterinary medicinal products are available to treat this condition (EMEA, 2000; Huet et al., 2005). However, their use in food-producing animals is prohibited in the EU (inclusion in Annex II of Commission Regulation (EC) No 37/2010[27]), United States, and other Third Countries in consideration of the potential harmful effects on human health. Toxicological investigations suggested a risk for carcinogenic and genotoxic effects and the occurrence of residues, with an intact imidazole structure, such as hydroxymetronidazole, covalently bound to tissue macromolecules, particularly proteins (EMEA, 1997, 2009b, 2009c). Although prohibited for use on food-producing animals, nitroimidazoles are likely to be available on the non-authorized supply chain for illicit use in poultry production. Illicit use of nitroimidazoles in poultry production, including metronidazole which is readily available as a human medicine throughout the EU, cannot be excluded.

[44] Substances with an intact 5-imidazole structure.

Non-compliant results for nitroimidazoles in poultry, and in other species, have been reported in most years in the results of the NRCPs. In poultry, 14 of the 91 non-compliant samples reported during the period 2005 to 2010 for group A are non-compliant samples for nitroimidazoles.

In view of the availability of nitroimidazoles, the occurrence of positive residue samples in the national residue monitoring programmes, and the toxicity profile of these substances, nitroimidazoles have been allocated to the category of high potential concern.

(c) Nitrofurans

Similarly to nitroimidazoles, nitrofurans were banned for use as VMPs because no ADI could be established due to positive results in genotoxicity testing. Nitrofurans, including furazolidone, furaltadone, nitrofurantoin and nitrofurazone, are very effective antimicrobial agents that, prior to their prohibition for use on food-producing animals in the EU in 1995, were widely used on livestock (cattle, pigs, and poultry), aquaculture and bees. A characteristic of nitrofurans is the short half-life of the parent compounds and the formation of covalently-bound metabolites which, under the acidic conditions of the human stomach, may be released as active agents. The tissue-bound metabolites of nitrofurans have been shown to be carcinogenic and mutagenic. It is important to note that these covalently-bound metabolites are used as marker residues for detecting the illicit use of nitrofurans in animal production.

The European Commission funded a research project in 1999 entitled "FoodBRAND" that studied methodologies for determining abuse of nitrofurans and, also, undertook a retail survey of pig meat in 15 European countries to establish the extent of abuse (O'Keeffe et al., 2004). This survey identified samples positive for nitrofurans in three MSs. In the case of poultry, substantial use of nitrofurans was identified in some MSs in 2003 (Rapid Alert System in Food and Feed) and a problem relating to release of furazolidone from sediments in old water tanks in poultry production units was identified in a Member State in 2004 (FSA, 2005). In poultry, 20 of the 91 non-compliant results reported during the period 2005 to 2010 for group A are non-compliant results for nitrofurans and these occur in each year of the six-year reporting period.

In view of the availability of nitrofurans, the various indications for use in poultry, the occurrence of positive residue samples in the NRCPs, and the toxicity profile of these substances, nitrofuranshave been allocated to the category of high potential concern.

2.4.2.2. Substances classified in the category of medium potential concern

2.4.2.2.1. Contaminants: Non dioxin-like polychlorinated biphenyls (NDL-PCBs) and other compounds (polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDDs))

In the category of substances of medium potential concern are contaminants such as the NDL-PCBs, and emerging compounds (PBDEs and HBCDDs) as they all tend to accumulate in edible tissues of slaughter animals, but representative data on the actual amounts in edible tissues are generally lacking.

(a) Non dioxin-like PCBs (NDL-PCBs)

In contrast to DL-PCBs, NDL-PCBs show a different toxicological profile, in particular with respect to effects on the developing nervous system and neurotransmitter function and have therefore been allocated to the group of substances of medium potential concern. In 2005, the CONTAM Panel performed a risk assessment on NDL-PCBs in food (EFSA, 2005). In the final conclusion, the CONTAM Panel stated that no health based guidance value for humans can be established for NDL-PCBs because simultaneous exposure to NDL-PCBs and dioxin-like compounds hampers the interpretation of the results of the toxicological and epidemiological studies, and the database on effects of individual NDL-PCB congeners is rather limited. There are, however, indications that subtle developmental effects, being caused by NDL-PCBs, DL-PCBs, or polychlorinated dibenzo-p-

dioxins/polychlorinated dibenzofurans alone, or in combination, may occur at maternal body burdens that are only slightly higher than those expected from the average daily intake in European countries.

In its risk assessment, the CONTAM Panel decided to use the sum of the six PCB congeners -28, -52, -101, -138, -153 and -180 as the basis for their evaluation, because these congeners are appropriate indicators for different PCB patterns in various sample matrices and are most suitable for a risk assessment of NDL-PCBs on the basis of the available data. Moreover, the Panel noted that the sum of these six indicator PCBs represents about 50 % of total NDL-PCBs in food (EFSA, 2005).

Harmonized European maximum levels for NDL-PCBs in different food categories including poultry meat, poultry meat products and poultry liver apply from 1 January 2012. Because some individuals and some European (sub)-populations may be exposed to considerably higher average intakes, a continued effort to lower the levels of NDL-PCBs in food is warranted.

(b) Other compounds: polybrominated diphenyl ethers and hexabromocyclododecanes

Compounds identified by the CONTAM Panel as emerging in the food chain were also included in the ranking.

Polybrominated diphenyl ethers (PBDEs)

In 2011, EFSA performed a risk assessment on PBDEs in food (EFSA, 2011a). PBDEs are additive flame retardants which are applied in plastics, textiles, electronic castings and circuitry. PBDEs are ubiquitously present in the environment and likewise in biota and in food and feed. Eight congeners were considered by the CONTAM Panel to be of primary interest: BDE-28, -47, -99, -100, -153, -154, -183 and -209. The highest dietary exposure is to BDE-47 and -209. Toxicity studies were carried out with technical PBDE mixtures or individual congeners. The main targets were the liver, thyroid hormone homeostasis and the reproductive and nervous system. PBDEs are not genotoxic. The CONTAM Panel identified effects on neurodevelopment as the critical endpoint, and derived benchmark doses (BMDs) and their corresponding lower 95 % confidence limit for a benchmark response of 10 %, the $BMDL_{10}$s, for a number of PBDE congeners: BDE-47, 309 µg/kg body weight (b.w.); BDE-99, 12 µg/kg b.w.; BDE-153, 83 µg/kg b.w.; BDE-209, 1 700 µg/kg b.w. Due to the limitations and uncertainties in the current database, the Panel concluded that it was inappropriate to use these BMDLs to establish health based guidance values, and instead used a margin of exposure (MOE) approach for the health risk assessment. Since elimination characteristics of PBDE congeners in animals and humans differ considerably, the Panel used the body burden as starting point for the MOE approach. The CONTAM Panel concluded that for BDE-47, -153 and -209 current dietary exposure in the EU does not raise a health concern.

For BDE-99 there is a potential health concern with respect to current dietary exposure. The contribution of poultry meat and poultry derived products to the total human exposure is currently not known. PBDEs, particularly BDE-99, have been allocated to the group of substances considered as being of medium potential health concern; occurrence data are required for all poultry species to confirm or refute this ranking.

Hexabromocyclododecanes (HBCDDs)

In 2011, EFSA delivered a risk assessment on HBCDDs in food (EFSA, 2011b). HBCDDs are additive flame retardants primarily used in expanded and extruded polystyrene applied as construction and packing materials, and in textiles. Technical HBCDD predominantly consists of three stereoisomers (α-, β- and γ-HBCDD). Also δ- and ε-HBCDD may be present but at very low concentrations. HBCDDs are present in the environment and likewise in biota and in food and feed. Data from the analysis of HBCDDs in 1 914 food samples were provided to EFSA by seven European countries, covering the period from 2000 to 2010. The CONTAM Panel selected α-, β- and γ-HBCDD to be of primary interest. Since all toxicity studies were carried out with technical HBCDD, a risk

assessment of individual stereoisomers was not possible. Main targets were the liver, thyroid hormone homeostasis and the reproductive, nervous and immune systems. HBCDDs are not genotoxic. The CONTAM Panel identified neurodevelopmental effects on behaviour as the critical endpoint, and derived a benchmark dose lower confidence limit for a benchmark response of 10 % ($BMDL_{10}$) of 0.79 mg/kg b.w. Due to the limitations and uncertainties in the current data base, the CONTAM Panel concluded that it was inappropriate to use this BMDL to establish a health based guidance value, and instead used an MOE approach for the health risk assessment of HBCDDs. Since elimination characteristics of HBCDDs in animals and humans differ, the Panel used the body burden as starting point for the MOE approach. The CONTAM Panel concluded that current dietary exposure to HBCDDs in the EU does not raise a health concern.

The occurrence data reported to EFSA have shown that HBCDDs could be detected in a number of poultry meat samples as well as hens eggs. HBCDDs have been allocated to the group of substances considered as being of medium potential health concern. Occurrence data are required for all poultry species to confirm or refute this ranking.

2.4.2.3. Substances classified in the category of low potential concern

2.4.2.3.1. Prohibited substances

Prohibited substances that might be used for growth promotion purposes in other species (stilbenes, thyreostats, steroids, resorcylic acid lactones, β-agonists), but for which there is no history of widespread abuse in poultry and/or which are unsuitable for such use in poultry, have been allocated to the category of substances of low potential concern. In poultry, 8 of the 91 non-compliant results reported during the period 2005 to 2010 for Group A are non-compliant results for steroids, of which 6 were for 17β-oestradiol. Only one incident of non-compliant results for the β-agonist clenbuterol occurred in 2007 when three poultry feed samples from a single Member State were reported as containing residues. Considering the strict dose-dependency of the pharmacological effects of clenbuterol, the low levels found in poultry are a low potential concern.

2.4.2.3.2. Veterinary medicinal products and feed additives: antibacterials, anthelmintics, anticoccidials, non-steroidal anti-inflammatory drugs and others (olaquindox)

Veterinary medicinal products which have an application in poultry production are categorised as being of low potential concern because they have all been subjected to pre-marketing approval which specifies ADIs, and subsequently MRLs, with the aim of guaranteeing a high level of safety to the consumer. Compounds for which toxicological data are incomplete or for which no toxicological ADI could be defined are excluded from authorization. Where exceedances of MRLs are found in the residue monitoring programmes (i.e. non-compliant results), these are typically of an occasional nature that do not constitute a concern to public health.

(a) Antibacterial VMPs (B1)

Antibacterial products are widely used in poultry and other livestock in the EU. The range of products comprises pharmaceutical products for injection or for oral application; the latter is the preferred route of treatment for large groups of poultry.

Relatively detailed breakdown of antibacterial VMP non-compliance incidents in the EU have only been available since 2004. The overall level of non-compliant results detected is low, such as 180 out of the 103 209 (0.17 %) of samples analysed for B1 (antibacterial) group in the EU for the period 2005-2010. Residues of tetracyclines, fluoroquinolones and sulfonamides have been the most frequently detected in non-compliant results obtained from targeted sampling according to the NRCPs. This level of incidents for these three categories presumably relates to different factors, including the long withdrawal periods for some pharmaceutical products. The level of recent non-compliant incidents for the other antibacterial categories in EU poultry has either been much lower (macrolides) or in all other cases, zero (penicillins, cephalosporins, aminoglycosides, pleuromutilins). Again, it needs to be emphasized that this evaluation addresses only toxicological concerns; the other risks such

as, for example, the occurrence of antimicrobial resistance and resistance gene transfer is addressed in that part of the document provided by the BIOHAZ Panel.

(b) Anthelmintics

Macrocyclic lactones (avermectins) are licensed antiparasitic substances which are used in poultry in a variety of formulations of ivermectin or doramectin, such as for treatment of poultry lice. There has been only one recent non-compliance incident in the EU, a sample non-compliant for ivermectin in 2008, with no other non-compliant results being recorded in the NRCPs over the period 2005-2010.

Other anthelmintic substances which are licensed for poultry include benzimidazoles and levamisole, used as oral formulations. There have been few recent non-compliance incidents in the EU. Two samples from one Member State were non-compliant for oxfendazole in 2006, with no other non-compliant results being recorded in the NRCPs over the period 2005-2010.

(c) Anticoccidials

Currently there are 11 anticoccidial compounds (also known as coccidiostats) licensed for use as feed additives in poultry feeds in the EU following premarketing approval by EFSA (FEEDAP Panel). In addition, the CONTAM Panel of EFSA has published opinions on each of the 11 compounds (regarding cross-contamination of feeds at the feed mill, and hence exposure of non-target animal species) (EFSA 2007a, b, 2008 a, b, c, d, e, f, g, h, i). According to the NRCPs, numerous incidents of non-compliance have occurred in the recent past, so these compounds continue to be of concern. Of 37 944 samples tested for anticoccidials over the 2005-2010 period, 696 were non-compliant (1.8 % of all samples tested).

The results from the NRCPs 2005-2010 for poultry show that non-compliant results for anticoccidials represent one-half to three-quarters of the non-compliant results recorded across all groups of substances in each year; 49, 59, 68, 77, 70 and 69 % of the total non-compliant results for poultry for 2005, 2006, 2007, 2008, 2009 and 2010, respectively.

Ionophores

The ionophore anticoccidials comprise lasalocid, maduramicin, monensin, narasin, salinomycin and semduramicin. Further analysis of the NRCPs data for anticoccidials shows that, when results for nicarbazin are discounted (as explained more fully in the Section on non-ionophores below), the ionophores, particularly lasalocid, maduramicin, salinomycin and monensin, account for approximately 70 % of the non-compliant results for anticoccidials over the period 2005-2010 and non-compliant samples occurred in each year of testing. This relatively high prevalence of non-compliant results for ionophores in poultry necessitates ongoing attention.

Non-ionophores

The non-ionophore anticoccidials comprise decoquinate, diclazuril, halofuginone, nicarbazin, robenidine, amprolium and clopidol. Further analysis of the residue monitoring programme data for anticoccidials shows that the anticoccidial nicarbazin is the main substance implicated, representing 68, 91, 75, 81, 81 and 63 % of the total non-compliant results for anticoccidials for 2005, 2006, 2007, 2008, 2009 and 2010, respectively. Over the six-year period of reporting, 7 to 10 MSs reported non-compliant results for nicarbazin and, in each year, 3 to 4 MSs were responsible for the vast majority of the non-compliant results reported. The reasons for this pattern of distribution of non-compliant results for nicarbazin may be the following:

a) the extent to which nicarbazin was used as the anticoccidial of choice in poultry production within particular MSs;

b) the extent to which testing for residues of nicarbazin in poultry were undertaken in particular MSs;

c) this approach adopted by particular MSs to testing for residues of nicarbazin in poultry, in terms of tissue tested (e.g. liver versus muscle, where differences in residue concentrations are typically 20-fold or greater) and national limits applied (in the absence of EU-specified MRLs).

Recently, EU MRLs for nicarbazin in poultry tissues have been specified by Commission Regulation (EC) No. 875/2010[41] (4000, 4000, 6000, 15 000 µg/kg dinitrocarbanilide, the marker compound for nicarbazin, for muscle, skin/fat, kidney and liver, respectively). Considering the relatively high values of these MRLs, it is expected that the incidence of non-compliant results for nicarbazin will decline markedly.

Of the non-ionophoric anticoccidials, when results for nicarbazin are discounted, non-compliant results for diclazuril and robenidine occur in most years of the NRCPs 2005-2010, with occasional occurrence of non-compliant results for amprolium, clopidol, decoquinate and toltrazuril sulfone.

(d) Non-steroidal anti-inflammatory drugs (NSAIDs)

This category of licensed anti-inflammatory substances includes salicylates, flunixin, fenamic acids, (keto-)profens and oxicams in a variety of formulations. Many of these products are also licensed and used widely in other species. Non-compliant samples for NSAIDs in poultry have been reported in each year in the results of the EU national residue monitoring programmes 2005-2010. There have been 20 non–compliant samples out of the 4 195 samples tested during the six-year period (0.48 % of the total samples analysed).

(e) Others: Olaquindox and carbadox (quinoxalines)

Olaquindox and carbadox are no longer authorised as feed additives in the EU as farm and feed mill workers are a special risk group for these genotoxic and carcinogenic compounds when handling animal feed. Occasional non-compliance cases for olaquindox (5 non-compliant results during the 2005-2010 period) have been noted in the EU. Because of the relatively low incidence of non-compliance results, this substance is allocated to the low risk category for poultry.

2.4.2.3.3. Contaminants: organochlorine and organophosphorus compounds, chemical elements, mycotoxins (aflatoxin B1), theobromine and nicotine

Contaminants with a toxicological profile that does not include specific hazards following accidental exposure of consumers, and which are generally not found above MLs in poultry were ranked as of low potential concern. This applies to organochlorine and organophosphorus compounds, chemical elements, mycotoxins, and secondary plant metabolites such as, for example, the alkaloid nicotine.

(a) Organochlorine pesticides

Organochlorine pesticides, such as dichlorodiphenyltrichloroethane (DDT) and its metabolites, hexachlorocyclohexanes (HCHs), dieldrin, toxaphene and others have been included in the category of contaminants of low potential concern. Occurrence of residues of these substances has declined over the years, because of their long-standing ban, and relatively low levels in animal products can be expected as shown by results from the NRCPs. There have been 4 non-compliant results for organochlorine pesticides during the six-year period 2005-2010.

(b) Organophosphorus compounds

Organophosphorus compounds may be used as veterinary medicinal products (antiparasitics) in animals, including poultry. A typical indication in poultry is infestation with red mite (*Dermanyssus gallinae*). However, the infrequent use of organophosphorus compounds and their short half-life in

poultry results in the allocation of these compounds to the category of low potential concern. No non-compliant results of the 1 248 samples tested for organophosphorus compounds were reported during the period 2005-2010. Testing for this category of compounds is not under the provisions of Council Directive 96/23/EC.[8]

(c) Chemical elements (cadmium, lead and mercury)

In total, 52 non-compliant samples out of the 11 828 poultry samples tested for chemical elements in the period 2005-2010 have been recorded. In this group, 39 of the 52 con-compliant results were associated with cadmium (Cd) residues, representing 75 % of the total non-compliant samples for the group. No information is given in what poultry species or in which tissues the residues have been found. As Cd accumulates in kidneys, it cannot be excluded that these positive samples represent results for renal tissues. In poultry, kidney tissue (which has not the typical kidney shape) may remain in the carcass during processing. However the quantity of kidney tissue is low and will in most cases not be consumed. Considering the short life-span of broiler chicks (which is by far the major age-group used for human consumption, see Section 1.1) and the fact that toxic heavy metals do not accumulate in muscle tissue (the tissue with the highest human consumption) these metals were allocated to the group of chemicals being of low potential concern. It should be mentioned that no data are available on other elements, such as copper, selenium and zinc, which are used as mineral feed additives, but which also are unlikely to accumulate in muscle tissue.

(d) Mycotoxins: aflatoxin B1

It should be noted that testing for mycotoxin residues in poultry is specified in Council Directive 96/23/EC,[8] but the range of mycotoxins tested in poultry under the NRCPs by MSs is limited; aflatoxins and ochratoxin A are tested by most MSs, with zearalenone and deoxynivalenol being tested in only a few MSs.

Only one non-compliant result for aflatoxin B1 was found during the six-year period 2005-2010. Considering also the short half-life of aflatoxins in poultry, and the low contribution of animal tissues to overall human exposure (EFSA, 2004), this mycotoxin is also considered to be of low concern.

(e) Other compounds: nicotine

Investigations in 1996 and 2006 have shown the illegal application of nicotine in poultry farming against mites. As a consequence, several million eggs were withdrawn from the market. This seems to be an historical case but requires consideration, as such incidents (non-licensed use) might be expected also in the future. This assumption is confirmed as there have been 2 non compliant results (2006 and 2010) for nicotine in the period investigated (2005-2010). Nicotine belongs to the group of natural plant alkaloids and exhibits at therapeutic concentrations a variety of pharmacological effects. The illegal use of nicotine may give rise to concerns related to animal welfare but, considering the toxicological profile, the short half-life and the infrequent use, potential residues are of low public health concern.

It should be noted that this compound is not required to be tested in poultry under the provisions of Council Directive 96/23/EC.[8]

2.4.2.4. Substances classified in the category of negligible potential concern

This category comprises substances irrelevant in poultry production (no known use at any stage of production) with no evidence for illicit use or abuse in poultry, which are not or very seldom associated with exceedances in MRL levels in NRCPs, and for which there is no evidence of occurrence as a contaminant in poultry feeds.

2.4.2.4.1. Prohibited substances

In the negligible potential concern category are the prohibited substances, chloroform, colchicine, dapsone and plant remedies containing *Aristolochia* species, as these are not relevant to poultry production and there is no evidence for illicit use or abuse of these substances in poultry production.

2.4.2.4.2. Veterinary medicinal products (VMPs) below MRLs: carbamates and pyrethroids, sedatives

VMPs used in poultry production but with no evidence for residues above MRLs being found in monitoring programmes and VMPs irrelevant for poultry production are ranked as of negligible potential concern) Carbamates and pyrethroids

Carbamates and pyrethroids are used in animal houses and occasionally in animals including poultry for control of environmental infections, such as lice eggs in buildings. There are no recent incidents of non-compliance reported in EU poultry during the period 2005-2010, resulting in the allocation of these substances to the category of negligible potential concern.

(b) Sedatives

A range of sedative substances including barbiturates, promazines, xylazine and ketamine, are licensed for use in poultry and other animal species for sedation and analgesia during surgical procedures or for euthanasia. They are rarely used in farmed birds. Due to their rapid excretion, these substances generally do not have detectable residues in muscle and so do not have MRLs registered in the EU. Animals euthanized with these substances are not allowed to enter the food chain. However, it should be mentioned that testing for this category of substances is not required under the provisions of Council Directive 96/23/EC.[8]

2.4.2.4.3. Contaminants: Dyes

There are no indications for use of dyes such as (leuco-)malachite green in poultry. Testing of poultry for this group of substances is not required under Council Directive 96/23/EC.[8]

A summary of the outcome of the ranking is presented in Table 8.

2.4.2.5. Future aspects

The ranking into specific categories of potential of prohibited substances, veterinary medicinal products and contaminants presented in this Section mainly applies to broilers and turkeys and is based on current knowledge regarding the toxicological profiles, usage in poultry production, and occurrence as residues, as demonstrated by the data from the NRCPs for the 2005-2010 period. Where changes in any of these factors occur, the ranking might need amendment. This may also include emerging compounds such as, for example, perfluorinated compounds and specific mycotoxins.

Future sampling should take into account differences in animal husbandry practices (indoor vs. outdoor), feed supply (industrial vs. home-produced feed) and life-span of the poultry categories (from just over 1 month for broilers to 3-6 months or even 18 months for spent hens) that may result in a different likelihood of occurrence of particular residues and contaminants.

Table 8: Ranking of chemical residues and contaminants in poultry based on pre-defined criteria and taking into account the findings from the NRCPs for the period 2005-2010.

Group / Potential concern / Category	Prohibited substances	VMPs and licensed feed additives	Contaminants
Category1 **Negligible potential concern**	- *Aristolochia* spp. - Chloroform - Colchicine - Chlorpromazine - Dapsone	- VMPs below MRLs	- Dyes
Category 2 **Low potential concern**	- Resorcylic acid lactones - Stilbenes - Thyreostats - Beta-agonists - Steroids	- VMPs exceeding MRLs - Anticoccidials - Olaquindox-carbadox (quinoxalines*)	- Organochlorine pesticides - Organophosphorus compounds - Chemical elements (Cadmium, Lead, Mercury) - Mycotoxins - Nicotine
Category 3 **Medium potential concern**			- NDL-PCBs - PBDEs - HBCDDs
Category 4 **High potential concern**	- Chloramphenicol - Nitrofurans - Nitroimidazoles		- Dioxins - Dioxin-like polychlorinated biphenyls (DL-PCBs)

*Quinoxalines are no longer licensed for used as feed additives according to Regulation EC No 2788/98.[45]
VMPs: veterinary medicinal products; MRLs: maximum residue limits; NRCPs: National Residue Control Plans; NDL-PCBs: non dioxin-like polychlorinated biphenyls; PBDEs: polybrominated diphenyl ether; HBCDDs: hexabromocyclododecane; DL-PBCBs: dioxin-like polychlorinated biphenyls.

3. Strengths and weaknesses of the current meat inspection methodology

Ante- and *post-mortem* poultry inspection is different from *ante-* and *post-mortem* inspection of mammals. In the case of poultry, inspection is limited generally to visual inspection of external surfaces including eviscerated organs. The very short inspection time and the smaller size of poultry carcasses generally preclude the identification of suspect animals. In addition, for poultry the flock is the epidemiological unit and all FCI is provided at flock/farm level.

In the light of the existing Regulations and the daily practice of the control of residues/chemical substances in poultry, the strengths and weaknesses of the current meat inspection methodology can be summarized as follows:

3.1. Strengths of the current meat inspection for chemical hazards

- The current procedures of sampling and testing are in general well-established, co-ordinated and are subject to regular evaluation across EU MSs, with residue and contaminant testing based on common performance standards (Commission Decision 2002/657/EC[46]), laboratory accreditation (ISO/IEC 17025) and quality assurance schemes. Residue and contaminant monitoring programmes are supported by a network of EU and National Reference Laboratories and by research in the science of residue and contaminant analysis that serves to provide state-of-the-art testing systems for control of residues and contaminants.

[45] Commission Regulation (EC) No 2788/98 of 22 December 1998 amending Council Directive 70/524/EEC concerning additives in feedingstuffs as regards of authorisation for certain growth promoters. OJ L 347, 23.12.98, p. 31-32.
[46] Commission Decision of 12 August 2002 implementing Council Directive 96/23/EC concerning the performance of analytical methods and the interpretation of results. OJ L 221, 17.8.2002, p. 8-36.

- There are well-developed systems and follow-up mechanisms following identification of non-compliant samples. As indicated in the previous Section, follow-up on non-compliant results is typically through intensified sampling (suspect sampling), withholding of slaughter and/or of carcasses subject to positive clearance as compliant, and on-farm investigations potentially leading to penalties and/or criminal prosecutions.

- The system is well-endorsed by sector stakeholders throughout the entire food chain (national and international farmers associations, poultry feed/meat industry, retailers). There is a high degree of FCI, particularly for the major poultry species, that is provided to the slaughterhouse in the poultry industry.

- The regular sampling and testing for chemical residues and contaminants is a disincentive for the development of undesirable practices.

- The prescriptive sampling system allows for equivalence in the control of EU domestic poultry. Forthcoming measures have to ensure that the control of imports from Third Countries remains equivalent to the controls within the domestic market (this issue is addressed further in TOR 4).

- The current combination of FCI, *ante-* and *post-mortem* inspection has been found, in general, to be supportive of the collection of appropriate samples for monitoring of chemical residues and contaminants.

3.2. Weaknesses of the current meat inspection method for chemical hazards

- Chemical hazards are unlikely to be detected by clinical observation of a flock at farm level or by visual *ante-/post-mortem* meat inspection at the slaughterhouse.

- According to Council Directive 96/23/EC,[8] sampling of tissue specimens for the analysis of residues or contaminants is prescriptive in terms of the number of samples that need to be taken. In such sampling plans, neither the actual feed chain information nor any species-specific information (age and origin of the animals) is considered.

- At present, there is poor integration between the testing of feed materials for undesirable contaminants and the NRCPs in terms of communication and follow-up testing strategies or interventions.

- There is limited inclusion of emerging chemical substances into mandatory monitoring.

- There is limited scope to take into account in the NRCPs the risk of exposure of diverse poultry species in different husbandry systems to a range of substances and to adapt sampling plans to the actual risk profile.

4. New hazards

Current monitoring of chemical residues and contaminants in edible tissues of slaughter poultry is based on Council Directive 96/23/EC.[8] In turn, ranking of potential concern as presented under TOR 1 is also based largely on the chemical substances listed in Council Directive 96/23/EC.[8] The outcome of the ranking showed that only a small number of compounds are considered to constitute a potential concern for consumers.

However, considering the recent information from literature and from the re-assessment of undesirable substances in the food chain, as reported in EFSA Opinions of the CONTAM Panel, additional compounds have been identified that require attention. Prominent examples of such substances are dioxins, DL-PCBs and NDL-PCBs, which were identified as high and medium potential concern substances, as they accumulate in food-producing animals and have a toxicological profile that points

towards potential public health concerns even at low concentrations. In addition, it has been shown that these substances are found in edible poultry tissues.

Other halogenated substances such brominated flame retardants, including PBDEs, as well as HBCDDs, and perfluorinated compounds have different toxicological profiles and likely present lower potential concern (EFSA 2008j, 2011a, b). However, these compounds also accumulate in food-producing animals and deserve attention, as currently knowledge about the prevalence and levels of these compounds in edible poultry tissues is limited. Inclusion of these substances in NRCPs (even as a temporary measure) should therefore be considered together with an intensified monitoring of feed materials for the presence of these compounds, to support forthcoming decisions on whether or not these substances require continued monitoring either in feed materials and/or in slaughter animals.

New technologies such as the production of bioethanol and biodiesel, and the increasing availability of new by-products suitable for inclusion in animal feeds from these technical processes are an issue of potential concern. For example, distillers dried grains are known to contain unexpected high concentrations of mycotoxins and need to be addressed in hazard identification and may require new testing strategies and methods (multi-toxin analyses). In addition, as a consequence of the emerging need for plant (vegetable) oils in bioethanol production, processing aids and toxic plant metabolites (such as gossypol) may (re)appear in the food chain.

5. Adaptation of inspection methods

Ante- and *post-mortem* inspection of poultry carcasses does not allow for simple identification of the presence of chemical residues and contaminants. Only cases of acute intoxications may be identified by clinical signs or significant changes in body composition. These changes should be noted already in the living animal prior to slaughter and should be regarded as part of the FCI or of the *ante-mortem* inspection. Therefore the contribution of *post-mortem* visual inspection of the carcasses at the time of slaughter is of limited value to exclude chemical hazards. The control of undesirable or hazardous chemicals in poultry, in the context of current meat inspection, depends almost entirely on the samples taken and analyzed according to the NRCPs.

Moreover, it should be noted that poultry farming in the EU is diverse (i.e. animal species, age, indoor, outdoor, integrated, conventional, organic farming) and hence the risk-profile for individual farms will vary.

With regard to chemical residues and contaminants, the food chain information (FCI) needs to include the following data:

- key characteristics of the poultry business and details of the production site, such as type of housing (indoor vs. outdoor systems), protocols for all treatments (VMPs and feed additives) of animals, with details on the individual pharmaceutical product, method of application, time and duration of treatments;
- information on other chemical substances used on the farm during the production period, such as pesticides and sanitizing agents;
- information on all feed materials (including water) used on the farm for poultry and traceability of the feed supply chain;
- for out-door production systems, information on contaminants in the soil to which the poultry have access.

For any farm not providing appropriate FCI data, tailored sampling plans might need to be developed. There is a need for an improved integration of sampling, testing and intervention protocols across the food chain, NRCPs, feed control and environmental monitoring.

In addition, there is a need to develop new approaches to testing. Recent developments in chemical analytical techniques allow the simultaneous measurement of a broad range of substances. Application of such methods for multi-residue analyses comprising drugs, pesticides and natural and environmental contaminants should be encouraged.

Finally, any measures taken to improve the efficacy of meat inspection protocols should also address the compliance of imports to the EU with these strategies. Where EU meat inspection would move to a risk-based approach, particular attention to the achievement of equivalent standards of food safety for imported food from Third Countries will be required. Currently, within the prescriptive system for meat inspection and residue monitoring applying in the EU, Third Countries exporting food products of animal origin to the EU need to demonstrate that they have the legal controls and residue monitoring programmes capable of providing equivalent standards of food safety as pertain within the EU. The risk-ranking appropriate within the EU in relation to veterinary drugs and contaminants might not be appropriate in Third Countries to achieve equivalent standards of food safety. Rather than requiring that a risk-based monitoring programme applying within EU MSs should be applied similarly in the Third Country, an individual risk assessment for each animal product(s)/Third Country situation may be required, which should be updated routinely.

CONCLUSIONS AND RECOMMENDATIONS

TOR 1. To identify and rank the main risks for public health that should be addressed by meat inspection at EU level. General (e.g. sepsis, abscesses) and specific biological risks as well as chemical risks (e.g. residues of veterinary drugs and contaminants) should be considered. Differentiation may be made according to production systems and age of animals (e .g. breeding compared to fattening animals).

CONCLUSIONS

- As a first step in the identification and ranking of chemical substances of potential concern, the EFSA Panel on Contaminants in the Food Chain (CONTAM Panel) considered substances listed in Council Directive 96/23/EC[8] and evaluated the outcome of the residue monitoring plans for the period 2005-2010. The CONTAM Panel noted that only approximately 0.27 % of the total number of results was non-compliant for one or more substances listed in Council Directive 96/23/EC[8] and thus chemical substances in poultry are unlikely to pose an immediate or acute health risk for consumers. Consequently, potentially higher exposure of consumers to these residues from poultry or poultry products takes place only incidentally, as a result of mistakes or non-compliance with known and regulated procedures. However, in the absence of substance-specific information, such as the tissues used for residue analysis and the actual concentration of a residue or contaminant measured, these data do not allow a reliable assessment of consumer exposure.
- The highest overall proportion of non-compliant results under the National Residue Control Plans (NRCPs) were for Group B1/B2 substances (0.51 %) representing largely exceedances of the maximum residue limits (MRLs) specified for these substances. The lowest proportion of non-compliant results overall (0.05 %) were for Group A substances representing largely illicit use of these substances. The intermediate proportion of non-compliant results was for Group B3 substances (0.21 %), representing largely exceedances of the MRLs/maximum levels (MLs) specified for these substances.
- Criteria used for the identification and ranking of chemical substances of potential concern included the identification of substances that accumulate in food-producing animals, substances with a specific toxicological profile, and the likelihood that a substance under consideration will occur in poultry. Taking into account these criteria the individual contaminants were ranked into four categories denoted as of high, medium, low and negligible potential concern.

- Dioxins and dioxin-like polychlorinated biphenyls (DL-PCBs) were ranked as being of high potential concern due to their known accumulation in food-producing animals, the risk of exceedance of maximum levels, and in consideration of their toxicological profile.
- Chloramphenicol and the groups of nitrofurans and nitroimidazoles were ranked as being of high potential concern, as they have a distinct toxicological profile comprising a potential concern for human health and residues in poultry have been found in the course of the NRCPs in various Member States (MSs), although these substances are prohibited for use in food-producing animals in the European Union.
- Non dioxin-like polychlorinated biphenyls (NDL-PCBs), polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDDs) also accumulate in food-producing animals, but were ranked in the category of medium potential concern, because they are less toxic than dioxins and DL-PCBs. Occurrence data are required for all poultry species to confirm or refute this ranking, in particular for PBDEs and HBCDDs.
- Residues originating from other substances listed in Council Directive 96/23/EC[8] were ranked in the low or negligible potential concern category due to the low toxicological profile of residues of these compounds and the absence or seldom association with exceedances in MRLs or MLs. This category includes, among others, organochlorine and organophosphorus compounds, chemical elements, mycotoxins, natural plant toxins, as well as residues of veterinary medicinal products, anticoccidials, and prohibited substances such as chlorpromazine, dapsone, resorcylic acid lactones, stilbenes, thyreostats, *beta*-agonists and steroids.
- The CONTAM Panel emphasises that this ranking into specific categories of potential concern mainly applies to broilers and turkeys and is based on current knowledge regarding the toxicological profiles, usage in poultry husbandry and likelihood of occurrence of residues and contaminants in edible tissues of poultry.
- Differences in animal husbandry practices (indoor vs. outdoor), feed supply (industrial vs. home-produced feed) and life-span of the poultry categories (from just over 1 month for broilers to 3-6 months or even 18 months for spent hens) can result in a different likelihood of occurrence of particular residues and contaminants.
- It is to be noted that there is a lack of detail provided on results, in particular for non-compliant samples, for the NRCP from MSs. This hampers the interpretation and the evaluation of data.

RECOMMENDATION

- Regular updates of the ranking of chemical compounds in poultry presented in this document as well as of the sampling plans should take into account any new information regarding the toxicological profile of residues and contaminants, usage in poultry production, and actual occurrence of individual substances in poultry, with special emphasis on newly identified feed contaminants and environmental pollutants that may enter the food chain.

TOR 2. To assess the strengths and weaknesses of the current meat inspection methodology and recommend possible alternative methods (at *ante-mortem* or *post-mortem* inspection, or validated laboratory testing within the frame of traditional meat inspection or elsewhere in the production chain) at EU level, providing an equivalent achievement of overall objectives; the implications for animal health and animal welfare of any changes suggested in the light of public health risks to current inspection methods should be considered.

CONCLUSIONS

Ante- and *post-mortem* poultry inspection is different from *ante*- and *post-mortem* inspection of mammals. In the case of poultry, inspection is limited generally to visual inspection of external

surfaces including eviscerated organs. The very short inspection time and the smaller size of poultry carcasses generally preclude the identification of suspect animals. In addition, for poultry the flock is the epidemiological unit and all Food Chain Information (FCI) is provided at flock/farm level.

From the evaluation of the strengths and weaknesses of current meat inspection the CONTAM Panel concluded that

- The current procedures for sampling and testing are in general well-established and co-ordinated including follow-up mechanisms following identification of non-compliant samples.
- The system is well-endorsed by sector stakeholders and the regular sampling and testing for chemical residues and contaminants is a disincentive for the development of undesirable practices.
- The prescriptive sampling system allows for equivalence in the control of EU domestic poultry. Forthcoming measures have to ensure that the control of imports from Third Countries remains equivalent to the controls within the domestic market.
- A weakness is that chemical hazards are unlikely to be detected by traditional *ante-/post-mortem* meat inspection.
- The current NRCPs prescribe the number of samples that need to be taken but do not necessarily take into account information related to feed control. Integration between NRCP, feed control and environmental monitoring is currently limited.

RECOMMENDATION

- Any new methods of meat inspection and related sampling and testing should include, in addition to the recognised strengths of the current system, consideration of animal husbandry and FCI, and better integration of feed control with chemical residues and contaminants monitoring.

TOR 3. If new hazards currently not covered by the meat inspection system (e.g. *Salmonella, Campylobacter*) are identified under TOR 1, then recommend inspection methods fit for the purpose of meeting the overall objectives of meat inspection. When appropriate, food chain information should be taken into account.

CONCLUSIONS

- Dioxins and DL-PCBs which accumulate in food-producing animals have been ranked as being of high potential concern. As these compounds have not yet been comprehensively covered by the sampling plans of the current meat inspection, they should be considered as "new" hazards.
- In addition, for a number of other organic contaminants that also may accumulate in food-producing animals very limited data regarding residues in poultry are available. This is the case, in particular, for (i) NDL-PCBs, (ii) brominated flame retardants, including PBDEs as well as HBCDDs.
- New technologies such as the production of bioethanol and biodiesel, and the increasing availability of new by-products used as animal feeds from these technical processes are issues of potential concern.

RECOMMENDATION

- Control programmes for residues and contaminants should include new and emerging substances and should be regularly updated.

TOR 4. To recommend adaptations of inspection methods and/or frequencies of inspections that provide an equivalent level of protection within the scope of meat inspection or elsewhere in the production chain that may be used by risk managers in case they consider the current methods disproportionate to the risk, e.g. based on the ranking as an outcome of terms of reference 1 or on data obtained using harmonised epidemiological criteria. When appropriate, food chain information should be taken into account.

CONCLUSIONS

- The contribution of visual clinical *ante-mortem* inspection of a flock and of *post-mortem* inspection of the carcasses is of limited value for the identification of chemical hazards. Therefore, control of undesirable or hazardous chemicals in poultry, in the context of current meat inspection, depends almost entirely on the samples taken and analyzed for residues and contaminants.

- Poultry farming in the EU is diverse (i.e. animal species, age, indoor, outdoor, integrated, conventional, organic farming) and hence the risk-profile for individual farms will vary.

RECOMMENDATIONS

- Sampling of poultry should be based on the available FCI.
- The frequency of sampling for farms should be adjusted to the appropriateness of the FCI presented.
- Analytical techniques covering multiple analytes should be encouraged and incorporated into feed quality control and national residue control plans.

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ABBREVIATIONS

ADI	Acceptable daily intake
AVEC	Association of Poultry Processors and Poultry Trade in the EU Countries
b.w.	Body weight
BIOHAZ Panel	EFSA Panel on Biological Hazards
BMD	Benchmark dose
BMDL	Benchmark dose limit
CONTAM Panel	EFSA Panel on Contaminants in the Food Chain
CVO	Chief Veterinary Officers
DL-PCBs	Dioxin-like polychlorinated biphenyls
EFSA	The European Food Safety Authority
EMA	The European Medicines Agency
EU	European Union
FAO	Food and Agriculture Organization
FCI	Food chain information
FEEDAP Panel	EFSA Panel on Additives and Products or Substances used in Animal Feed
HBCDD	Hexabromocyclododecane
HCH	Hexachlorocyclohexanes
IPCS	International Programme on Chemical Safety
ML	Maximum level
MOE	Margin of exposure
MRL	Maximum residue limit
MRPL	Minimum Required Performance Limit
MSs	Member States
NC	Non compliant
NDL-PCBs	Non dioxin-like polychlorinated biphenyls
NOAEL	No-observed-adverse-effect level
NRCPs	National Residue Control Plans
NSAIDs	Non-steroidal anti-inflammatory drugs
PBDE	Polybrominated diphenyl ether
PCBs	Polychlorinated biphenyls
PCP	Pentachlorophenol
TEQ	Toxic equivalent
TWI	Tolerable weekly intake
VMPs	Veterinary medicinal products
WHO	World Health Organization

APPENDIX C FROM THE ANIMAL HEALTH AND WELFARE PANEL (AHAW PANEL)

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SUMMARY

In the meat inspection system, *ante-* and *post-mortem* inspection are recognised as valuable tools for surveillance and monitoring of specific animal health and welfare issues. Meat inspection is often a key point for identifying outbreaks of existing or new disorders or disease syndromes in situations where clinical signs are not detected on-farm. In the course of normal commercial procedures, *ante-* and *post-mortem* inspection of poultry is an appropriate and practical way to evaluate the welfare of poultry on-farm, and the only way to evaluate the welfare of poultry during transport and associated handling.

Two key consequences of omission of visual *post-mortem* inspection on surveillance and monitoring for poultry health and welfare were identified: the loss of opportunities for data collection about the occurrence of existing or new disorders or disease syndromes or welfare conditions of poultry, and the potential for carcasses with pathological changes, currently condemned during visual *post-mortem* inspection, to be further processed without the infectious nature of some conditions being detected.

If visual *post-mortem* inspection is removed, other approaches should be explored and applied to compensate for any associated loss of information about the occurrence of animal disease and welfare conditions. Two approaches are outlined. Firstly, it is recommended that *post-mortem* checks continue on each carcass that is removed from the food chain, as part of a meat quality assurance system for example, due to visible pathological changes or other abnormalities. In addition, it is proposed that detailed inspection is conducted on a defined subset of carcasses from each batch, guided by FCI and other epidemiological criteria, to obtain information about animal disease and welfare conditions. The intensity (number of birds sampled) of targeted surveillance within each batch should be risk-based, with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch.

Extended use of FCI has the potential to compensate for some, but not all, of the information on animal health and welfare that would be lost if visual *post-mortem* inspection is removed. This can only occur if FCI are designed to identify indicators for the occurrence of animal health and welfare conditions. FCI for public health purposes may not have an optimal design for surveillance and monitoring of animal health and welfare; therefore, an integrated system should be developed where FCI for public health and for animal health and welfare can be used in parallel.

1. Introduction

1.1. Overview of the current situation

A major aim of the current meat inspection system for poultry is to protect the public from hazardous materials, including infectious agents. *Ante-mortem* inspection, and the further investigation that occurs during *post-mortem* inspection, allows identification of aspects of pathology in birds at slaughter, and prevention of meat from obviously sick or abnormal birds entering the food chain. Meat inspection makes it possible to detect and withdraw from the food chain all carcasses that present grossly identifiable abnormalities that might affect the safety or wholesomeness of the final product (Lupo et al., 2010b). The system has also been applied to monitor and improve specific animal health and welfare issues. Relevant to animal health, the system can contribute to the detection of a disease condition not previously known to exist on the farm and this is particularly important for small farms. These disease conditions may have an important impact on animal health on the farm of origin or in the regional poultry population. For instance, the poultry meat inspection system, both *ante-* and *post-mortem*, has contributed to the early detection of Newcastle disease virus infection, in situations where clinical signs on-farm have been ignored. Meat inspection can also enable detection of important parasitic conditions, such as coccidiosis when present at a high level (Permin and Hansen, 1998), leading to actions to limit their impact on poultry production. Relevant more specifically to animal welfare, information collected during both *ante-* and *post-mortem* inspection may reveal deaths, injuries or pathological lesions that indicate poor welfare caused by conditions and treatment on-farm or during handling and transport. Indicators relevant to on-farm conditions include hock-burn, foot-pad dermatitis and ascites while those relevant to handling and transport include death, broken bones and bruising. Thus, the meat inspection system is valuable for maintaining a reliable food supply using healthy animals, and for improving animal health and welfare.

1.1.1. Changes in the poultry industry: consequences for meat inspection

There have been on-going changes in the poultry industry in recent decades, including modifications with the aim of intensifying production and increasing economic efficiency (EFSA 2010a and EFSA 2010b). These modifications have impacts on public health and on animal health and welfare. They have also influenced the efficiency of the detection of pathogens and other hazards in poultry during the meat inspection process. It is necessary to consider these challenges, and to modify the procedures somewhat whilst maintaining the integrity and value of the inspection for better public health, animal welfare and animal disease management within Europe.

1.1.2. Changes in public interest: consequences for meat inspection

Animal product quality will nowadays often include consumer health, dietary desirability, animal welfare, environmental impact and a fair price for producers, as well as taste and cost. Many aspects of the sustainability of production systems are also now considered (Aland and Madec, 2009; Broom, 2010, 2012). People are less tolerant than in the past of poor treatment of animals and more likely to expect food retailers to ensure that all components are of good quality. A consequence of this changed situation is an increased demand from the public for (i) an ability to check each of the above-mentioned issues, (ii) product traceability and (iii) detailed and accurate labelling. The public and the animal production industries also have increased expectations that animal disease will be prevented or effectively managed.

1.1.3. Policy responses

The European Commission has responded to these changes in public attitudes, one response being the development of systems, through the application of animal-based welfare-outcome indicators, to identify major welfare problems on-farm and during transport (EFSA 2010a and EFSA 2010b; EFSA 2011a,Welfare Quality®). The methodology is best developed for poultry and aspects are outlined in Council Directive 2007/43/EC that are required to be used *on-farm*, usually by the farmer, and *at the abattoir prior to slaughter*, usually by an independent person.

Efforts have also been made to manage animal disease, for example, the European Commission has successfully implemented stringent demands to reduce the burden of human cases of salmonellosis derived from poultry by reducing the prevalence of *Salmonella* infections during production (EFSA 2012b;). A second example is advice on how to prevent the introduction of pathogens e.g. H5 and H7 strains of influenza virus from migrating birds (EFSA 2006; EFSA 2008).

The procedures during *ante-* and *post-mortem* meat inspection are described in an external report to EFSA entitled *'Overview on current practices of poultry slaughtering and poultry meat inspection'*[47], and are not repeated here. The work focuses on broilers, however, other domestic poultry species (e.g. turkeys, ducks and spent hens) are also considered. The significance of food chain information during meat inspection, from primary production forward, is highlighted. Variation in meat inspection practices among EU countries is also mentioned.

1.1.4. Animal health

One aim of meat inspection in issues related to animal health requires that '*particular attention is to be paid to the detection of zoonotic diseases and diseases on OIE list'* (Reg. 854/2004, Annex I, Chapter II, part D). The detection of animal health concerns can be classified in two groups:

- detection of specific signs potentially caused by important pathogens (e.g. caused OIE listed or industrially important, endemic, diseases), and
- signs of general character (e.g. weight distribution) which may be indicators for health status of the group or indicators for further investigations, including more careful look for specific signs.

In meat inspection of poultry, the epidemiological unit of interest is generally at the level of the flock[48] or batch[49], rather than the individual animal, which influences the design of surveillance activities. The size of the flocks may vary (commonly 10,000 or 30,000 birds). A flock for slaughter may be inspected at the farm of origin (depending on the decision of the competent authority) and consists of an inspection as well as insights into the history of these birds, including the origin of feedstuff (Fries 2007). The density of the birds and stage of production will each influence the value of on-farm inspection. As required under Regulation (EC) No 854/2004, information from such checks should be submitted to the slaughterhouse as part of food chain information (FCI), for review and analysis by the official veterinarian (OV). However, if an inspection has not been undertaken on-farm, it should be organised at the abattoir. There are several technological factors which would influence the detection of signs of diseases or pathological conditions during meat inspection, including the number of birds to be processed, the speed of the processing line (e.g. up to 12,000 birds per hour), the availability of technological adjustments (e.g. mirrors, line dividers, special video-/thermo-cameras and software), the number of birds selected to be examined in greater depth (sampling design strategy), etc. Although some poultry diseases have been decreasing in frequency due to effective control methods, some have re-emerged due to new management or production systems, and new diseases or pathogens have appeared. Meat inspection is often a key point for identifying outbreaks of existing or new diseases or disease syndromes. The detection at meat inspection could provide an 'information alert' in case of suspected diseases with epidemic character (e.g. avian influenza, Newcastle disease), or important feedback for some endemic diseases (e.g. infectious bursal disease, mycoplasmosis), parasitic diseases (e.g. histomoniasis, coccidiosis) or other poultry health related conditions. A delay or failure of detection may lead to large and sometimes widespread epidemics, particularly when multiple

[47] www.efsa.europa.eu/en/supporting/pub/298e.htm

[48] Flock. There may be one or more flocks on a farm, defined by housing. For the purpose of this opinion, all the birds in one house constitute one epidemiological unit and are referred to as a single flock.

[49] Batch. The batch is defined by timing of transport to the slaughterhouse. The normal procedure would be to slaughter an entire flock at one time, however, one flock may be broken into several batches for slaughter ('batches') at different times.

slaughterhouses are being used and there is the potential for a large number of premises to be connected (Dent et al., 2008).

1.1.5. Animal welfare

In order to implement Council Directive 2007/43/EC, welfare indicators have to be monitored. Such monitoring is briefly described here. However, proposals from the European Commission to develop animal-based welfare-outcome indicators to evaluate welfare on-farm and during transport have resulted in a series of EFSA opinions, including one on poultry (EFSA 2010a, 2010b and EFSA 2012). Future opportunities to achieve this are discussed in section 2.2.2.3. Many broiler chickens, turkeys, ducks and geese reared for meat production grow fast and may have leg problems resulting in walking disorders, leg pain and food pad lesions due to excessive contact with poor quality litter. This is best documented for broiler chickens (Bradshaw et al., 2002). Ascites, leg disorders and other welfare problems on farm can result in deaths that are readily counted during *ante-mortem* inspection. *Post-mortem* monitoring gives more detailed information about broiler welfare. The welfare of laying hens is also sometimes monitored at the slaughterhouse, for example the occurrence of birds that are dead or that have broken bones. For hens, and for poultry used in meat production, poor welfare during transport is usefully assessed during *ante-* or *post-mortem* inspection. Some of these welfare indicators cannot be assessed on-farm and others are less likely to be assessed by the farmer than at the slaughterhouse.

The following are examples of animal-based welfare indicators that are, or may be, monitored during *ante-mortem* inspection:

- *On-farm before loading*
    - Infectious/epidemic diseases present/not present, mortality of the herd at/below/above average, important information on disease status eg. on AI and ND.
    - Other welfare indicators such as dirty feathers, diarrhoea, high numbers of lame birds, check on a limited number of birds on pododermatitis etc.
- *During catching, both by hand and by harvester machines*. Because of the speed of the process, there is limited time for inspection. Staff are usually not trained for bird inspection, and therefore only dead or very thin birds can be removed.
- *During unloading at the slaughter house* (dead on arrival, very weak or dying birds, very dirty birds, emaciated birds, panting, ability to move, broken bones etc.) This can work in plants with electrical or CO2 stunning when birds are unloaded on conveyor belts leading in the gas tunnel. However, this works only when birds are removed from their transport boxes before stunning. In some systems with CO2 stunning, the transport boxes go un-opened in the gas tunnel. At the point of shackling after stunning, it is difficult to identify birds that died during transport, body temperature "cold" birds, which were lame, broken bones are only seen in obvious severe cases. Emaciated birds, feather cleanliness etc. can evenly be assessed, but, time is very short, and staff's primary duty is to shackle the birds.

2. Implications for surveillance and monitoring for poultry health and welfare of changes to meat inspection as proposed by BIOHAZ

2.1. The proposed BIOHAZ changes

The proposed changes to the meat inspection system are presented elsewhere, in BIOHAZ appendices to the Opinion, but include:

- Removal of visual *post-mortem* inspection and substituting it by methods for detection of foodborne pathogens (incl. detection of faecal carcass contamination), and

- Incorporating food chain information (FCI).

2.2. Qualitative assessment

The role of the AHAW Panel was to identify the implications for animal health and welfare of any changes to the current meat inspection system as proposed by the BIOHAZ and CONTAM Panels. Two broad methods were used during this assessment, including a qualitative approach (review of international literature, expert opinion) (section 2.2) and results from quantitative modelling (2.3).

2.2.1. Materials and Methods

2.2.1.1. Review of international literature

A literature search was performed using databases integrated in the ISI web of knowledge to identify published articles under the scope of AHAW work in the mandate. The search focused on 1) species of interest, 2) place of control inspection, 3) the scope of effects, and 4) some specific activities. The detailed search strings are described in the Appendix.

2.2.1.2. Expert opinion

The WG members presented and refined their views, following detailed discussion within the working group.

An overview of the current meat inspection procedures for poultry in the EU has been reported[47], and will be followed in this assessment.

2.2.2. Results and Discussion

2.2.2.1. Removal of visual *post-mortem* inspection

The current assessment was conducted to assess the impact of this proposed shift in focus, in terms of implications of surveillance and monitoring for poultry health and welfare. Currently, *post-mortem* inspection conducted on carcasses at the slaughterhouse is carried out through visual inspection, providing animal health and welfare information relevant to the situation on farm, during transport and at the slaughterhouse including indicators of adequate stunning. It is agreed, as reflected in the BIOHAZ Appendix, that current *post-mortem* procedures cannot detect the main food safety risks borne by poultry meat. Therefore, if one were to focus solely on a risk-based strategy to protect public health, it may be reasonable to eliminate visual inspection from the actual procedures, without increased risk for consumers, if thorough surveillance and inspection on zoonotic diseases is carried out on the farms.

The responsibility for poultry meat inspection lies with official veterinarians (OVs), and auxiliary personnel working under their supervision. Birds are subjected to an initial *post-mortem* inspection after plucking and transfer to the evisceration line. At this point, alterations detected during visual inspection (e.g. small size, ascites, cellulitis, abnormal colours or bone fractures) will lead to partial or complete condemnation of the bird. Immediately after evisceration, carcasses and viscera are visually inspected, which may also result in partial or total condemnation if abnormalities are detected.

Overall, the condemnation rate in the EU during *post-mortem* inspection is between 1 and 2% of carcasses and the most common alterations leading to condemnation of poultry carcasses or viscera include abnormal colouration, bruising and fractures, ascites, liver necrosis, cellulitis, air sac inflammation, septicaemia and peritonitis, salpingitis, arthritis, and cachexia (according to data presented in the overview of current meat inspection procedures)[47]. Few of these poultry health and welfare conditions can be identified during on-farm inspection. In a national study of male turkeys at slaughter in France during 2006, the within-flock weighted average condemnation proportion was 1.8% (95% confidence interval, 1.3–2.3%; Lupo et al., 2010b). In a study of broilers slaughtered in France during 2005, a condemnation rate between 0.85 and 0.89% was observed (Lupo et al., 2009).

The average within-flock condemnation rates for reasons relating to infections (health-related problems of presumed infectious or metabolic origin, including emaciation, congestion, arthritis/polyarthritis, ascites) were 0.53% (ranging from 0 % to 3.71%), and to trauma (such as infected skin lesions, bruises and wounds, abnormal colour, odour or conformation) were 0.19% (ranging from 0% to 1.72%) (Lupo et al., 2010a). The condemnation rate differed significantly according to the type of poultry produced (standard, light, heavy or certified). Heavy weight flocks had a significantly higher condemnation rate than standard flocks (Lupo et al., 2008). In a national survey in Lithuania during 2000-2009, pathological lesions were identified in 0.95% of poultry, with the majority (98.7%) of registered pathologic lesions typical of non-infectious diseases. In this study, the incidence of non-infectious diseases was highest in turkeys (average 8.3%), but also present in chickens (1.3-2.1% of slaughtered birds) and ducks (0.00 to 0.29%). In each of the commercial poultry species, infectious diseases were rarely observed. In turkeys, infectious diseases were diagnosed in 0.02–0.07% of birds without clinical signs, whereas, in ducks no infectious diseases were diagnosed, and in chickens cases were rare (Januškeviciene et al., 2010).

Diagnosis during visual *post-mortem* inspection is based on morphological criteria, and often not related to a specific aetiology; therefore, it is not possible to distinguish the number of condemnations attributable to infectious and non-infectious causes. In the French study of male turkeys at slaughter, the most common officially reported reasons for condemnation in male turkeys were emaciation, arthritis–polyarthritis and congestion, representing 76% of the condemned carcasses (Lupo et al., 2010b). In the French study of broilers at slaughter, the main reasons for condemnation were emaciation and congestion, with rates of 30 and 22 per 10,000 birds slaughtered, respectively. Congestion was significantly associated with arthritis and ascites, whereas infected skin lesions were associated with bruises and abnormalities of colour, odour or conformation (Lupo et al., 2008). Some of the general signs observed at *post-mortem* (e.g. weight variation) might be present concurrent with, or a consequence of, endemic diseases (e.g. mycoplasmosis) in the flock of origin (Kopecsnick, 2008). These conditions are mainly a reflection of common endemic diseases and welfare problems, rather than epidemic animal diseases, with the majority posing a limited public health risk.

Post-mortem inspection of carcasses is primarily used to detect and withdraw from the food chain all carcasses that present grossly identifiable abnormalities that might affect safety or wholesomeness of the final product (Lupo et al., 2010b). However, data from *post-mortem* inspection are also used for monitoring and surveillance for poultry health and welfare, principally relating to endemic diseases and welfare conditions. For example, information about *Mycobacterium avium* can be gathered during *post-mortem* inspection. Relevant information for detection of epidemic diseases such as avian influenza and Newcastle disease may be acquired more effectively on-farm, through ante-mortem inspection or through FCI documents, rather than through *post-mortem* inspection. Similarly, the analysis of data on *post-mortem* lesions of broilers (e.g. haematomas, scratches, foot-pad dermatitis, breast blisters) is a common means to assess poultry welfare during rearing and pre-slaughter handling (Gouveia et al., 2009). Indeed, in the course of normal commercial procedures, there is no alternative to *post-mortem* inspection of carcasses for the evaluation of some aspects of poultry welfare, including breast-blisters, broken bones, bruising and skin lesions. Accurate scoring of other welfare conditions, including foot-pad dermatitis and hock-burn, can usefully be conducted during post-mortem inspection when birds are de-feathered and the feet are clean. In summary, there are several important welfare problems including breast-blisters, broken bones, bruising and skin lesions that result in conditions that can only be identified during post-mortem inspection at the abattoir.

Relevant to surveillance and monitoring for poultry health and welfare, there are two key consequences of omission of visual *post-mortem* inspection:

- Firstly, current opportunities for data collection during visual *post-mortem* inspection may be lost, with the concomitant loss in information about the occurrence of existing or new diseases or disease syndromes of poultry, in particular due to the loss of information from examination of condemned carcasses. Information on the occurrence of several important welfare

problems, including breast-blisters, broken bones, bruising and skin lesions, will be lost because such conditions can only be identified during *post-mortem* inspection at the abattoir.

- Secondly, there is the potential for carcasses with pathological changes, currently condemned and recorded during visual *post-mortem* inspection, to be further processed without the infectious nature of some conditions being detected. With respect to these carcasses, it is not known if the meat quality assurance system, as proposed, will achieve an equivalent sensitivity of detection as traditional visual meat inspection.

2.2.2.2. Incorporating food chain information

As required under Regulations (EC) No 853/2004 & 854/2004, meat inspection must be based on a risk assessment conducted on the entire food chain. To achieve this, meat inspectors must have access to relevant 'food chain information' (FCI) about the flock to be slaughtered, and the opportunity to pay particular attention to those batches where particular problems are expected (Blaha et al., 2007).

An example of FCI is given below, from the UK, covering a range of information about the poultry being sent for slaughter, such as:

- *General information about the birds:* species, breed or hybrid, age, production type: free range, housed or organic etc…, number of birds, batch identification reference…, proposed slaughter date,

- *General flock health:* maximum stocking density, mortality at 14 days, mortality to date: cumulative daily mortality rate, diseases that have been diagnosed, high mortality rate linked or not to a specific disease…, salmonella test requirements…, on flock health status

- *Medications used:* name of medication prescribed including vaccines and preventative medicines-coccidiostats, date of withdrawn, observation of the withdrawal period(s)

In addition, FCI could also include information about animal based welfare measures for poultry.

An example of a FCI form, from the UK

FCI is required to be supplied at least 24 hours before the arrival of animals at slaughterhouse, except where ante-mortem inspection is done at the farm. In this case the FCI and veterinary ante-mortem declaration is to accompany the animals to which they relate (Regulation (EC) No 853/2004, Annex II, Section III and Regulation (EC) No 854/2004, Annex I, Section I, Chapter II A and Section II, Chapter II.)

Part 1, 2 and 3 to be completed by the producer.

Part 4 to be completed by the slaughterhouse operator.

Part 5 to be completed by the Official or Approved Veterinarian.

Part 1: Producer details, Veterinary surgeon & practice details, Destination

Part 2: Information about poultry being sent for slaughter (species, breed or hybrid, age, production type: free range, housed or organic etc…, number of birds, batch identification reference…, proposed slaughter date, maximum stocking density, mortality at 14 days, mortality to date: cumulative daily mortality rate, name of medication prescribed including vaccines and preventative medicines-coccidiostats, date of withdrawn, observation of the withdrawal period(s), diseases that have been diagnosed, high mortality rate linked or not to a specific disease, salmonella test requirements

Part 3: Disease history of the holding: health status or voluntary restrictions, what type of restriction, if previous consignments are sent to a different slaughterhouse: rejection rate and reason of rejections….

Part 4: Slaughterhouse operator's check and comments

Part 5: Official or approved veterinarian's check and comments

As yet, only a limited number of epidemiological studies have been conducted in Europe to assess the added-value of FCI in the context of surveillance and monitoring for poultry health and welfare. Of particular importance is the question of whether FCI information from primary production could be used to predict the risk of condemnation. If this were the case, then FCI could form the basis for risk-based decisions about appropriate meat inspection procedures.

Lupo and coworkers (Lupo et al., 2008, 2009, 2010a,b) describe several studies investigating whether primary production information would predict the risk of condemnation. In a study of male turkey broilers, using data from 2006 from 117 flocks in 13 slaughterhouses located in Western France, three variables were found to be significantly associated with increased risk of condemnation: observed locomotor disorders on the farm, high cumulative mortality 2 weeks before slaughter, and clinical signs observed by the Veterinary Services during the *ante-mortem* inspection at the slaughterhouse (Lupo et al., 2010b). The final model explained 35% of the total variation in condemnation risk. Half of this explained variation could be attributed to locomotor disorders observed during rearing. The sensitivity and specificity of the model to predict a high flock condemnation risk were 80% and 74%, respectively, when using an optimum threshold of 0.95% to define high risk. The results of this study suggested that these variables could be used as indicators. They are each easily retrieved from the regulatory documents that are transmitted before flock arrival at the slaughterhouse, and could be used

to screen flocks before slaughter. The authors conclude that these indicators are potentially useful to aid meat inspectors to target their inspection efforts (Lupo et al., 2010b).

A similar study on chicken broilers was conducted, based on data collected in 2005 at 15 slaughterhouses from 404 flocks in western France (Lupo et al., 2009, 2010a). In initial work, a Poisson regression model of condemnation rate was developed, consisting of six simple and biologically relevant predictors: production type, frequency of farmer's visits during the starting period, health disorders during rearing, on-farm mortality, mortality during transport, and slaughter-line speed (Lupo et al., 2009). Accurate prediction of the condemnation rate for a given flock was not feasible, however, flocks with low or high risk of condemnation could be distinguished. These findings could be useful at various stages of chicken production, to monitor and improve farm husbandry practices, minimize the impact of transport conditions, and optimize meat inspection procedures (Lupo et al., 2009). More complex statistical analyses were subsequently performed to separately determine risk factors for condemnation as a result of infectious causes (such as emaciation, congestion, arthritis/polyarthritis, ascites) and trauma (such as infected skin lesions, bruises and wounds, abnormal colour, odour or conformation) (Lupo et al., 2010a). Independent variables were organised in blocks related to the different production stages (farm structure and routine husbandry practices, on-farm flock history and characteristics, catching, transport and lairage conditions, slaughterhouse and inspection features). Variables related to flock characteristics and history had the greatest impact on overall condemnation rate, with a relative weight of 40%. The relative weights of the three other explanatory blocks (catching, transport and lairage conditions [22%], farm structure and routine husbandry practices [20%], slaughterhouse and inspection characteristics [18%]), were very similar. Therefore, the causes contributing to condemnation are multifactorial, highlighting the importance of each of these pre-slaughter stages in explaining the condemnation process. In accordance with Regulation (EC) No 853/2004, farmers also require feedback from the meat inspection process (Lupo et al., 2010a).

Council Regulations, and the BIOHAZ changes, each highlight the importance of FCI to inform a risk-based approach to meat inspection. However, the FCI suggested by BIOHAZ are intended for public health purposes and may therefore not have an optimal design for surveillance and monitoring of animal health and welfare. FCI directed to major zoonotic agents, such as *Salmonella* and *Campylobacter* which usually does not result in clinical disease in poultry, are likely to be of minor importance for surveillance and monitoring of animal health and welfare. In contrast, FCI programmes that are directed to identifying indicators of animal health and welfare with a high risk of condemnation of carcasses at slaughter may have limited importance for public health. Extended use of FCI could thus compensate for some of the information on animal health and welfare that would be lost if visual *post-mortem* inspection were removed, but only if the FCI is designed to also identify indicators for the occurrence of animal health and welfare disorders. To this point, there are gaps in knowledge about the utility of FCI in risk-based meat inspection. It is not yet possible to accurately predict condemnation rates in a given flock based on the information gathered in the current FCI systems.

2.2.2.3. Opportunities, in light of the proposed changes

a. General comments

In the absence of a system of visual *post-mortem* inspection, it is recognised that an alternative meat quality control process will be needed to ensure the removal of all abnormal carcasses. Thus, all carcasses will still need to be checked. Reasons for condemnation are important, and these data should be collected. In addition, a system will be needed to compensate for a loss of surveillance and monitoring information (for reasons other than condemnation) following the removal of visual *post-mortem* inspection of all birds. It is proposed that this is achieved through detailed inspection of a defined subset of carcasses, guided by FCI and other epidemiological criteria. Therefore, FCI can be used to support, but not replace, visual *post-mortem* inspection in the detection of animal health and welfare concerns including disease. Specifically, FCI and other epidemiological criteria *(information*

flow from farm to abattoir) may assist in identifying flocks or batches at greatest risk of condemnation or other adverse animal health and welfare outcomes. Targeted meat inspection could then be conducted, through detailed visual *post-mortem* inspection of a representative subset of birds, to provide useful information about the prevalence of endemic diseases and welfare conditions in these higher-risk flocks or batches. The intensity (number of birds inspected) of targeted surveillance within each batch would be risk-based, with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch. The results of quantitative modelling, as outlined later, can be used to guide the sampling size required for specific disease or welfare conditions. Logically, this approach is only achievable through improvements in the capture of pre-slaughter FCI and epidemiological critieria, and once significant health and welfare indicators are identified. FCI in current usage includes information on mortality and the use of pharmaceutical treatments (Löhren, 2011).

The above-mentioned FCI-guided identification of high-risk flocks will be of limited public health importance, as these carcasses will be removed anyway. However, these carcasses represent the 'tip of the iceberg' in terms of the percentage of animals exposed to such disorders. For this reason, the implications of these conditions on animal health and welfare, and of associated production losses, are likely to be far greater than indicated by the number of birds being condemned at slaughter. We conclude that the optimal use of FCI can be a valuable tool, and an economic incentive, to minimise the costs associated with the estimated 1-2% condemnation rate. A reduction in condemnation will also prevent associated flock health and welfare problems during production.

Effective animal health and welfare monitoring and surveillance is reliant on a robust two-way information flow between farm and abattoir, as follows:

- *From the farm to the abattoir:* FCI and other epidemiological criteria to inform *ante-* and *post-mortem* meat inspection, and

- *From the abattoir to the farm:* The results of meat inspection to inform rational on-farm decision-making, including information relevant to stocking density and other factors to improve health and welfare on-farm.

Current FCI forms, as outlined in the previous UK example, include data relevant to both public health risks and animal health and welfare monitoring and surveillance, however, it is the former where attention is predominantly paid. There is a need to find ways to best use FCI at both *ante-* and *post-mortem* inspection in order to not only improve public health but also to improve animal health and welfare monitoring and surveillance. More research is needed to identify thouse aspects of FCI that are important for animal health and welfare monitoring and surveillance during meat inspection. There would be value in studies investigating the utility of FCI for a range of poultry health and welfare outcomes, in addition to condemnation.

A particular challenge with FCI relates to data validity, and the potential for the accuracy and completeness of data to be compromised if collected by persons with an economic or otherwise vested interest. Independent farm-based auditing may alleviate this concern, at least in part. In some countries, animal welfare data are increasingly collected as part of independent farm audits for certification, conducted in association with farm assurance schemes (Hubbard, 2012; Kilbride et al., 2012) and independent organisations, such as supermarkets.

During the modified slaughter process as outlined by BIOHAZ (that is, in the absence of visual *post-mortem* inspection), several methods are available to assist with data capture at slaughter. Automated methods offer the potential for data capture on all birds, relating to key animal-based welfare-outcome indicators, such as pododermatitis score and body shape (emaciation). Data capture may also be possible during meat quality assurance, if this were introduced to replace visual *post-mortem* inspection.

An extended use of FCI in the meat inspection process offers opportunities for an integrated use of animal-based welfare-outcome indicators, which the European Commission currently aim to use to check on the welfare of poultry and other farmed species, both on-farm and during transport. Their use will require data collection *ante-* and *post-mortem*, in some cases on all animals and in other cases on samples of animals. Some disorders, including broken bones, are only detectable during detailed examination.

The current feedback to farms of slaughter and batch weight, of data on the occurrence of death during transport, and of condemnation at slaughter are each used as broad measures on flock health and welfare. These systems of feedback *(information flow from abattoir to farm)* can be further improved. The following provides several examples of this, and the use of effective information flows between farm and abattoir to improve poultry health and welfare:

- In Sweden, the occurrence of foot-pad dermatitis in broilers is continuously monitored through inspection of feet after slaughter (Berg, 2004). Lesions are classified, and prevalence estimated, following reference to a photo guide of broiler foot health. This information is subsequently used to guide decision-making and management on-farm. An increase in population density in broiler houses, to a defined maximum, is contingent on the occurrence of foot lesions being below a defined level. This system offers economic incentives for producers to participate and to improve the welfare of their flock(s), whilst also conducting surveillance for other health and welfare issues. There are opportunities for the use of automated inspection, to identify foot-pad dermatitis. For broilers, hens and other poultry, the detection during *post-mortem* inspection of endemic disease, broken bones and other conditions is an important means of assessing prevalence.

- In several Scandinavian countries, risk categorisation of poultry flocks through application of FCI (collected on-farm and during slaughter) have been used to create an economic inventive towards improved general health and welfare during poultry production as described above. In e.g. Sweden and Finland, all flocks of broiler chickens are also tested for Salmonella contamination prior to slaughter. Although flocks found to be Salmonella-infected seldom show any clinical signs of disease or impaired welfare, the biosecurity measures to prevent similar events in subsequent flocks have been found to also prevent the occurrence of other infections, thus leading to a progressive improvement in general flock health and welfare. A similar improvement can also be achieved if special progressive targeted levels of contamination are set, as suggested by BIOHAZ. However, for poultry the FCI information on the occurrence of salmonella infection in a flock can be useful to guide the slaughter process; all contaminated flocks can either be destroyed and thus prevented from entering the abattoir or possibly be specially treated after slaughter. The same is applicable for other infections of animal or public health importance and there is thus a need to find ways on how the different kinds of FCI information is best used to improve public health as well as animal health and animal welfare.

- A study in the Netherlands provides comprehensive information on different methods for classification and scoring foot-pad dermatitis including an automatic system using video imaging as a method that may be used to verify the broiler flocks that are meeting the standard for foot lesions (WUR Report 2011).

b. Animal welfare assessment

Some food retailer standards and the implementation of the broiler Directive (2007/43/EC) already require welfare monitoring of the kind detailed below. Future legislation and codes of practice are likely to require that detailed monitoring for the evaluation of welfare on-farm and during transport becomes widespread. Broiler chickens arriving at the slaughter plant can be checked to assess whether or not they are able to stand. In addition the prevalence of hock-burn, foot pad dermatitis and breast blisters that result from weak legs and contact with litter of poor quality (wet and sticky litter; e.g.

Shepherd et al., 2010) can be measured. *Post-mortem* inspection after de-feathering can give a more precise evaluation of the degree of these problems (Broom and Reefmann 2005; EFSA 2012). Poor welfare in broilers on-farm, although with a much lower prevalence than leg problems, also results from ascites. The accumulation of fluid in organs is evident during *ante-mortem* and *post-mortem* inspection of the birds. Ascites, leg disorders and other welfare problems on farm can result in deaths that are readily counted during *ante-mortem* inspection.

In addition to the assessment of welfare in poultry kept for meat production, indicators of poor welfare in laying hens on-farm and during handling and transport can be evaluated during *ante-* and *post-mortem* inspection. Laying hens have a much lower prevalence of leg disorders, but inadequate exercise when kept in small cages and diet can result in osteopenia (Knowles and Broom, 1990, Leyndecker et al 2001). As a result of weak bones, bone breakage during catching and transport is greatly increased (Knowles et al., 1993). Rough handling of hens and other poultry can also result in bone breakage. Therefore, the occurrence of broken bones can give information about welfare on-farm and is a useful indicator of welfare during transport (Jendral, 2008; Shipov et al., 2010).

For all poultry, an indicator of poor welfare during transport is death-on-arrival. In a large consignment of poultry, the expected number of deaths during transport can be calculated and the extra number evident from the *ante-mortem* inspection then deduced. Poor transport conditions and poor handling can both lead to deaths. Injuries such as bruising and cuts, as well as the bone breakage mentioned above, are best assessed during *post-mortem* inspection.

It is feasible to use animal-based welfare-outcome indicators on-farm. These indicators include those of endemic disease conditions as well as other welfare issues. However, unless the person evaluating is independent, the result may not be accurate because of time constraints during the evaluation or bias on the part of the evaluator. It is difficult to obtain information about the welfare of large numbers of individual birds on-farm, for example in a broiler chicken house. This is much easier to achieve, for certain disorders, when each bird is inspected at *ante-* or *post-mortem* inspection by an independent person. Hence for evaluation of on-farm welfare of poultry, *ante-mortem* and *post-mortem* meat inspection procedures are most important. For evaluation of welfare during transport and associated handling, unless there is a special investigation of animals during transport, only *ante-mortem* and *post-mortem* inspection at the slaughterhouse can be used.

2.3. Quantitative assessment

In each of the AHAW meat inspection opinions, qualitative and quantitative approaches are being used to investigate the implications on animal health and welfare surveillance and monitoring of changes proposed by BIOHAZ and CONTAM. The quantitative methodologies are more complex in poultry than other species, in large part due to the multi-hierarchical nature of modern poultry production (in effect, the multiple levels of interest, including countries, compartments, zones, farms, flocks, batches, birds). *The simplified model* (outlined below) provides batch-level outputs, but no further insights relevant to the farm or the region. Similar constraints are not faced with other species.

2.3.1. Materials and Methods

A quantitative modelling approach was developed and used to assess the performance of animal health and welfare surveillance in abattoirs. Specifically, stochastic and deterministic models of the meat inspection system for poultry were developed *to investigate the probability of detection of specific diseases/conditions.* Stage 1 work was conducted to identify a limited number of diseases and conditions of poultry, for subsequent modelling. Stage 2 modelling relates to detection probabilities during *ante-* and *post-mortem* inspection, whereas stage 3 modelling considers the relative contribution of meat inspection within the overall surveillance system (of which meat inspection is a part). A *'freedom from disease'* model, with the output being detection probability, was developed for epidemic diseases, and a 'detection fraction' model was developed for endemic diseases and welfare conditions.

A detailed discussion about meat inspection and monitoring and surveillance for animal diseases and conditions is presented elsewhere (EFSA 2012b).

2.3.1.1. Stage 1 work

The modelling was conducted on a limited number of diseases and conditions of poultry, based on defined criteria (see Appendix A). For each disease/condition, a case definition was developed for both typical and mild cases. A detailed description of the stage 1 work is presented elsewhere (Annex (A) AHAW).

2.3.1.2. Stage 2 modelling

a. Explanation

Detailed methodology about the approach to stage 2 modelling is presented elsewhere (COMISURV report[50]). These models are subsequently termed *the COMISURV model*. In this opinion, we report output from two models: *the COMISURV model* and a modification, the latter being *a simplified model* that was developed specifically to explore the impact of a number of assumptions. From this point in this opinion, we refer to *the COMISURV model* and *the simplified model*.

The following provide an outline of the issues under consideration as *the COMISURV model* was modified, leading to development of *the simplified model*, to allow exploration of the impact of a number of assumptions.

- *Different levels:*
  - A number of different hierarchical levels may be considered during poultry and welfare surveillance, including the country, a compartment, a zone, the farm, a flock, a batch or an individual bird (see 2.3.3).
  - In *the simplified model*, analysis of the value of meat inspection in poultry health and welfare surveillance was conducted solely at the level of the (slaughter) batch.
- *Farm level nodes*
  - *The COMISURV model* includes two nodes ('Farm Category' and 'Farm Infected') operating at the farm level. As the unit of interest in the analysis is the batch (the outcome of the analysis is the batch sensitivity), farm-level factors play no role in the calculation. We consider that batches coming from the same farm have the same characteristics in regard to the concerned diseases. Batch sensitivity (or any sensitivity) is a probability conditional on the batch being infected or exposed to hazards resulting in 'bad welfare, either on-farm or during transport'. Factors influencing that probability are only relevant if the unit of interest for the analysis is at a higher level (e.g. sensitivity of the surveillance system at the national level).
  - Therefore, in *the simplified model*, these two nodes were omitted.
- *Animal-level risk factors*
  - The bird category of slow or fast growth was the only animal-level risk factor considered in *the COMISURV model*, and experts judged that it was only relevant for colisepticaemia, IBD and ascites. Sex was also considered but was not judged to be relevant for any disease. This factor is not discussed in the report, but is elsewhere

[50] External scientific report submitted by COMISURV to EFSA on the Contribution of meat inspection to animal health surveillance in poultry. Available on www.efsa.europa.eu

described as fast or slow growing genotype. While genotype is a bird-level characteristic, production systems currently have all birds of the same genotype within one batch, which means that it operates at a batch, flock or farm-level. As there is no variation within batch, there is no capacity for risk-based sampling within the batch.

- Even if there were variability within the batch, within a surveillance system, in order for a risk factor to influence the sensitivity of surveillance, risk-based sampling must be used. This means that animals with the risk factor have to be selected for further examination at a higher rate than animals without the risk factor. If representative sampling is used no matter what risk groups are present, there is no impact on sensitivity. Sampling of birds at slaughter is not based on identified risk factors, so these factors have no effect on the batch-level sensitivity.

- For these reasons, animal-level risk factors were omitted from *the simplified model*.

- *Bird status (infection node)*

  - This was retained in *the simplified model*, and represents the animal-level design prevalence. Animal-level (within-batch) design prevalence is the only design prevalence level that is relevant when assessing batch sensitivity.

- *Calculation of bird- and batch-level test sensitivity*

  - The *COMISURV model* treated ante-mortem inspections steps (food chain information and crate inspection) as animal-level tests (assuming that these had been performed for every animal). In *the simplified model*, these are considered as batch-level tests.

  - Bird-level sensitivity is calculated based on the listed *post-mortem* examination steps. Batch-level sensitivity is then based on the number of birds examined, and is then combined in parallel with the *ante-mortem* batch-level inspection sensitivity.

    Batch $Se_{Total} = 1-(1-Se_{BatchAM}) * (1-(Se_{BatchPM}))$,

    Where

    - $Se_{BatchAM}$ is the batch-level sensitivity of the food chain information and crate inspection as reported by experts, and

    - $Se_{BatchPM}$ is based on the number of birds inspected in the batch (n), individual bird sensitivity (Se_A) and assumed within-batch prevalence (P^*_A) as follows:

    $Se_{BatchPM} = 1- (1- P^*_A \times Se_A)^n$

    Se_A is the animal-level sensitivity, which is calculated as:

    - $Se_A = 1 - (\Pi(1-Se_{MICC}) \times (Se_{CT} \times P_{CT}))$,
    - Where
      - Se_{MIC} is the sensitivity of each component step in the *post-mortem* meat inspection
      - and, for those three diseases for which confirmatory tests were listed
        - P_{CT} is the probability of using a confirmatory test
        - Se_{CT} is the sensitivity of a confirmatory test

- In *the COMISURV model*, all birds were assumed to have an individual bird sensitivity equal to that estimated by experts for typical cases. *The simplified model* included an estimate of the average individual bird sensitivity, weighted by experts' estimates of the proportion of typical, mild and subclinical cases:
    - *Typical case* - sensitivity as estimated by experts based on MI steps
    - *Mild case* – both *post-mortem* sensitivity = 50% × Typical case sensitivity
    - *Subclinical case – ante-mortem* sensitivity = 0 and *post-mortem* sensitivity = 10% × Typical case PM sensitivity

- *Number of birds inspected*
    - Consistent with EU regulations, *the COMISURV model* assumed that every bird in the batch (using values of 10,000 and 30,000 as examples) would be examined with the same sensitivity. To explore situations where not all birds are examined, but were a subsample of birds are taken from the chain for more detailed examination, *the simplified model* examined the results of surveillance using a number of different smaller sample sizes.
    - This resulted in the removal of selection nodes from *the simplified model*, and use of different values for n (the number of birds inspected from the batch).

In conclusion, the factors taken into account in *the simplified model* were:

- The sensitivity of each step of meat inspection and subsequent confirmatory tests and the proportion of animals expressing different signs of disease (typical, mild and subclinical),
- The animal-level design prevalence, and
- The effective number of animals examined.

b. Batch-level sensitivity

The sensitivity of detection of an infected/affected batch depends on the average sensitivity of individual bird inspection, as well as the number of birds inspected from a batch and the animal-level design prevalence (the hypothetical proportion of infected birds in an infected batch). The ability to detect diseased batches at meat inspection was analysed in a number of different ways:

- Firstly, the batch-level sensitivity was estimated based on assumed within-batch prevalence values supplied by experts for the different diseases. For many diseases, the within-batch prevalence was assumed to be relatively high, providing very high batch-level sensitivity values.
- For comparison purposes, a second approach was used, in which a fixed assumed within-batch prevalence of 1% was applied across all diseases. These results make it easier to compare meat inspection surveillance performance between different diseases. For illustrative purposes, results are presented for three different sample sizes: 500, 100 and 10 birds inspected per batch.
- As the interpretation of the above results is so heavily dependent on the assumed prevalence, a third approach was used to interpreting the data. This involved deriving the prevalence of disease detectable with a probability equal to 95% (specified batch-level sensitivity = 95%).

This can be interpreted as the minimum prevalence of disease that could be detected with a confidence of 95%. The ability to detect disease at the batch level is also influenced by the number of birds that are examined.

c. Case detection

For endemic diseases, surveillance with the objective of finding cases of disease may be assessed using the detection fraction, or the proportion of cases in the population that are successfully identified by the surveillance system. In the current context, detection fraction may be assessed at two levels, the individual bird (the proportion of infected/affected birds within a batch that are detected), and the batch (the proportion of infected/affected batches that are affected). Detection fraction (in the absence of risk-based sampling) is simply the coverage multiplied by the sensitivity. This is because risk-based sampling is assumed to use animal- or batch-level factors or indicators that are not associated with the considered animal health issues.

2.3.1.3. Stage 3 modelling

Detailed methodology about the approach to stage 3 modelling is presented elsewhere (COMISURV report). We present outputs from *the COMISURV model*, without any modification to explore the impact of alternative assumptions.

a. Detection probabilities for epidemic diseases in the overall surveillance system

In this work, only one epidemic disease, avian influenza, was modelled at stage 3, using a conventional scenario tree model focusing on detection probability. Three surveillance system components (SSC) were considered for the purpose of analysis of the overall poultry surveillance system, including:

- clinical suspicion,
- abattoir inspection, and
- serological and/ or virological surveys.

All three are compulsory in Europe but serology is only done for a sample of batches.

b. Detection fractions for endemic diseases/conditions in the overall surveillance system

Four diseases/conditions were modelled, including three endemic diseases (aspergillosis, colisepticaemia and infectious bursal disease) and one welfare condition (ascites), using scenario tree models focusing on detection fraction.

2.3.2. Results and Discussion

2.3.2.1. Stage 2 modelling

a. Bird-level sensitivity

Table 1 lists the estimated sensitivity of detection of selected diseases and conditions of poultry in an individual affected bird.

Table 1: Sensitivity of detection of diseases/conditions in an individual affected bird based on expert opinion (COMISURV report). AM (*ante-mortem* inspection consisting of food chain information and crate inspection, conducted at the batch level), PM (*post-mortem* inspection) conducted at the individual bird level. *'Typical'* is the animal level sensitivity of *post-mortem* inspection for a typical case. *'Average case'* is the weighted average sensitivity across typical, mild and subclinical cases, assuming a 50% reduction in sensitivity for a mild case, and a 90% reduction in sensitivity for a subclinical case. *'Lab confirmed'* includes any follow-up confirmatory tests (only relevant to three diseases).

			Post-mortem (bird-level)		
Diseases and conditions		***Ante-mortem* (batch-level)**	**Typical**	**Average case**	**Lab confirmed**
Exotic	Highly Pathogenic Avian Influenza (HPAI)	98.0%	100.0%	41.0%	38.9%
	Newcastle disease (ND)	92.5%	99.9%	41.0%	34.7%
Endemic diseases	Coliform cellulitis (Gangrenous cellulitis)	73.0%	100.0%	43.0%	43.0%
	Mycoplasma gallisepticum infection	92.0%	98.1%	52.0%	52.0%
	Colisepticaemia	76.0%	99.9%	73.0%	73.0%
	Botulism	97.8%	0.0%	0.0%	0.0%
	Necrotic enteritis and hepatic disease	93.0%	99.6%	67.3%	67.3%
	Avian tuberculosis	93.0%	99.9%	48.5%	48.5%
	Egg peritonitis	61.5%	99.9%	32.5%	32.5%
	Duck plague	99.0%	100.0%	71.0%	71.0%
	Infectious bursal disease (IBD)	91.3%	98.7%	44.4%	44.4%
	Aspergillosis	76.0%	99.5%	60.7%	60.7%
	Histomoniasis	95.0%	99.9%	48.0%	48.0%
Welfare conditions	Thermal discomfort	85.0%	99.4%	60.6%	60.6%
	Dead on arrival (DOA)	90.0%	0.0%	0.0%	0.0%
	Traumatic injuries	99.0%	99.5%	99.5%	99.5%
	Pododermatitis	70.0%	80.0%	19.9%	19.9%
	Skin lesions	84.0%	100.0%	100.0%	100.0%
	Tarsal dermatitis	68.0%	99.7%	99.7%	99.7%
	Ascites	91.0%	100.0%	100.0%	100.0%

For typical cases, the AM and PM sensitivities for most diseases are both high, resulting in a very high sensitivity for the inspection process. The exceptions are botulism and DOA, which are not detectable at PM. Follow-up testing required for HPAI, ND and botulism decreases sensitivity significantly, due to both the risk that samples are not tested, and the imperfect sensitivity of the confirmatory tests. When all cases rather than typical cases are considered, the average sensitivity is significantly lower

for most diseases, but remains high for most welfare conditions except for pododermatitis which is expected to have a high proportion of subclinical cases.

Key points:

- For typical cases, there is an estimated high sensitivity of detection of most diseases/conditions in an individual affected bird during both *ante-* and *post-mortem* inspection. The exception is botulism, which is not detectable at *post-mortem*. When all, rather than typical, cases are considered, the estimated average sensitivity is significantly lower for most diseases, but remains high for most welfare conditions except for pododermatitis, which is expected to have a high proportion of subclinical cases.

b. Batch-level sensitivity

The batch-level sensitivity of surveillance (the probability that a batch, which is infected/affected at or above the design prevalence, will be detected by the surveillance system – i.e. at least one positive bird will be identified from that batch) is shown in Table 2, based on a design prevalence of 1%. Separate figures are provided for *ante-mortem* inspection (which are done at the batch level, and are therefore not influenced by the number of individual birds infected/affected), and *post-mortem* inspections (carried out at the individual level). For *post-mortem* inspections, the sensitivity over a range of sample sizes is shown.

Table 2: Batch-level sensitivity for *ante-* (AM) and *post-mortem* (PM) inspection for different disease and sample sizes, using a design prevalence of 1%, based on outputs from *the simplified model*.

Disease	AM	PM				
		1,000	500	100	10	1
HPAI	98.0%	98.0%	85.8%	32.3%	3.8%	0.4%
Newcastle	92.5%	96.9%	82.4%	29.3%	3.4%	0.3%
Coliform cellulitis	73.0%	98.7%	88.4%	35.0%	4.2%	0.4%
MG	92.0%	99.5%	92.6%	40.6%	5.1%	0.5%
Colisepticaemia	76.0%	99.9%	97.4%	51.9%	7.1%	0.7%
Botulism	97.8%	0.0%	0.0%	0.0%	0.0%	0.0%
Necrotic enteritis	93.0%	99.9%	96.6%	49.1%	6.5%	0.7%
Avian tuberculosis	93.0%	99.2%	91.2%	38.5%	4.7%	0.5%
Egg peritonitis	61.5%	96.1%	80.3%	27.8%	3.2%	0.3%
Duck plague	99.0%	99.9%	97.2%	51.0%	6.9%	0.7%
IBD	91.3%	**98.8%**	89.2%	35.9%	4.4%	0.4%
Aspergillosis	76.0%	99.8%	95.2%	45.6%	5.9%	0.6%
Histomoniasis	95.0%	99.2%	91.0%	38.2%	4.7%	0.5%
Thermal discomfort	85.0%	99.8%	95.2%	45.6%	5.9%	0.6%

Disease	AM	PM				
		1,000	500	100	10	1
DOA	90.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Injuries	99.0%	100.0%	99.3%	63.2%	9.5%	1.0%
Pododermatitis	70.0%	86.4%	63.1%	18.1%	2.0%	0.2%
Skin lesions	84.0%	100.0%	99.3%	63.4%	9.6%	1.0%
Tarsal dermatitis	68.0%	100.0%	99.3%	63.3%	9.5%	1.0%
Ascites	91.0%	100.0%	99.3%	63.4%	9.6%	1.0%

Key points:

- *Ante-mortem* inspection alone (if used correctly) has a relatively high probability of detecting most diseases and conditions in infected batches.
- Except for three diseases (botulism, DOA and pododermatitis), *post-mortem* inspection has a high probability of detecting the listed diseases/conditions, when a sample of 1,000 birds per batch or more is examined. If less than 500 birds per batch are examined, the sensitivity of *post-mortem* inspection is generally poor.
- Elimination of *post-mortem* inspection and the sole use of *ante-mortem* inspection (food chain information and cage inspection) would result in relatively high sensitivities (> 90%) for many of the diseases listed. Those with lower *ante-mortem* sensitivity include thermal discomfort (85%), skin lesions (84%), colisepticaemia (76%), aspergillosis (76%), coliform cellulitis (73%), pododermatitis (70%), tarsal dermatitis (68%) and egg peritonitis (62%).

The total batch-level sensitivity, based on the combined *ante-* and *post-mortem* sensitivities are show in Table 3 for different diseases and sample sizes. Experts were asked to provide estimates of the most likely prevalence of the disease in an infected batch, and this has been used as an alternate per-disease design prevalence (P^*_{expert}) in addition to a fixed design prevalence of 1%.

Table 3: Batch-level sensitivity for different diseases, sample sizes and design prevalence values, based on outputs from *the simplified model*. P^*_{expert} refers to the design prevalence (expected prevalence) derived from expert opinion for the different disease; n is the number of birds actually examined.

Disease	P^*_{expert}	Batch-level sensitivity, given:					
		n=500		n=100		n=10	
		P^*_{expert}	P* = 1%	P^*_{expert}	P* = 1%	P^*_{expert}	P* = 1%
HPAI	28.3%	100%	100%	100%	99%	99%	98%
Newcastle	~100.0%	100%	99%	100%	95%	100%	93%
Coliform cellulitis	22.5%	100%	97%	100%	82%	90%	74%
MG	40.0%	100%	99%	100%	95%	99%	92%
Colisepticaemia	30.8%	100%	99%	100%	88%	98%	78%
Botulism	15.0%	98%	98%	98%	98%	98%	98%
Necrotic enteritis	65.0%	100%	100%	100%	96%	100%	93%
Avian tuberculosis	15.0%	100%	99%	100%	96%	97%	93%
Egg peritonitis	25.0%	100%	92%	100%	72%	83%	63%
Duck plague	95.0%	100%	100%	100%	100%	100%	99%
IBD	90.0%	100%	99%	100%	94%	100%	92%
Aspergillosis	0.5%	95%	99%	82%	87%	77%	77%
Histomoniasis	40.0%	100%	100%	100%	97%	99%	95%
Thermal discomfort	60.0%	100%	99%	100%	92%	100%	86%
DOA	0.7%	90%	90%	90%	90%	90%	90%
Injuries	20.0%	100%	100%	100%	100%	100%	99%
Pododermatitis	18.1%	100%	89%	99%	75%	79%	71%
Skin lesions	79.7%	100%	100%	100%	94%	100%	86%
Tarsal dermatitis	59.8%	100%	100%	100%	88%	100%	71%
Ascites	1.1%	100%	100%	97%	97%	92%	92%

P*expert: The expected prevalence of disease in an infected/affected batch, as assessed by experts, and used as an alternative design prevalence to assess the capacity to detect disease at this level.
P*=1%: A constant design (or assumed) prevalence of 1% across all diseases.

Key points:

- Meat inspection, as currently practiced, is not equally effective in detecting different diseases/conditions of poultry.
- The total batch-level sensitivity is very dependent on the *ante-mortem* inspection sensitivity, with sample size only influencing the extra sensitivity provided by *post-mortem* inspection.
- The batch-level sensitivity is very dependent on the assumed design prevalence and the number of birds examined per batch. Batch-level detection probability increases with increased number of birds examined.

To illustrate the effect of removing assumed design prevalence values, Table 4 presents the minimum prevalence of disease that could be detected with a confidence of 95%, for different diseases and several different assumed numbers of birds examined.

Table 4: Prevalence of disease that meat inspection would be able to detect with a sensitivity of 95%, based on outputs from *the simplified model*, given different numbers of birds inspected per batch.

Disease	P^*_{expert}	Minimum prevalence of disease that could be detected with a confidence of 95%, given different numbers of birds inspected per batch				
		10	**50**	**100**	**200**	**500**
HPAI	28.3%	*26.2%*	*5.9%*	*3.0%*	*1.5%*	*0.6%*
Newcastle	100.0%	*27.3%*	*6.1%*	*3.1%*	*1.6%*	*0.6%*
Coliform cellulitis	22.5%	***31.4%***	*7.1%*	*3.6%*	*1.8%*	*0.7%*
MG	40.0%	***27.2%***	*6.1%*	*3.1%*	*1.6%*	*0.6%*
Colisepticaemia	30.8%	***29.3%***	*6.6%*	*3.3%*	*1.7%*	*0.7%*
Botulism	15.0%	***26.5%***	*5.9%*	*3.0%*	*1.5%*	*0.6%*
Necrotic enteritis	65.0%	*26.8%*	*6.0%*	*3.1%*	*1.5%*	*0.6%*
Avian tuberculosis	15.0%	***27.1%***	*6.1%*	*3.1%*	*1.6%*	*0.6%*
Egg peritonitis	25.0%	***35.9%***	*8.1%*	*4.1%*	*2.1%*	*0.8%*
Duck plague	95.0%	*26.0%*	*5.8%*	*3.0%*	*1.5%*	*0.6%*
IBD	90.0%	*27.4%*	*6.2%*	*3.1%*	*1.6%*	*0.6%*
Aspergillosis	0.5%	***29.8%***	***6.7%***	***3.4%***	***1.7%***	***0.7%***
Histomoniasis	40.0%	*26.7%*	*6.0%*	*3.0%*	*1.5%*	*0.6%*
Thermal discomfort	60.0%	*28.2%*	*6.3%*	*3.2%*	*1.6%*	*0.7%*
DOA	0.7%	***28.8%***	***6.5%***	***3.3%***	***1.7%***	*0.7%*
Injuries	20.0%	***26.0%***	*5.8%*	*3.0%*	*1.5%*	*0.6%*
Pododermatitis	18.1%	***34.3%***	*7.7%*	*3.9%*	*2.0%*	*0.8%*
Skin lesions	79.7%	*27.5%*	*6.2%*	*3.1%*	*1.6%*	*0.6%*
Tarsal dermatitis	59.8%	*29.3%*	*6.6%*	*3.3%*	*1.7%*	*0.7%*
Ascites	1.1%	***26.8%***	***6.0%***	***3.1%***	***1.5%***	*0.6%*

P*expert: The expected prevalence of disease in an infected/affected batch, as assessed by experts.
The cells in *italics* and '**bold**' highlight situations where the threshold for detection is higher than the expected by experts. This represents situations where surveillance should be considered inadequate to reliably detect the presence of the disease. The cells in *italics* indicated situations where the disease could be detected at levels equal to or lower than the expected prevalence.

Key points:

- For most disease, sampling 50 birds per batch yields adequate confidence of disease freedom, based on assumed prevalence. The exceptions are aspergillosis, DOA, pododermatitis and ascites.
- The assumed prevalence values are significantly higher than commonly used international standards. Depending on the purpose of surveillance, lower design prevalence values may need to be used.
- An increase in sample size (that is, the number of birds sampled for more intensive meat inspection), as could occur with increased use of food chain information, will result in a higher sensitivity of meat inspection (for a given design prevalence) or the ability to detect lower levels of disease (at a given batch-level sensitivity).

c. Case detection

Table 5 presents the detection fraction (the proportion of cases in the population that are detected during surveillance) for different diseases/conditions.

Table 5: The detection fraction achieved with meat inspection surveillance for a range of diseases/conditions of poultry, based on outputs from *the simplified model*. *At the bird level*, two different levels of coverage are specified, while coverage is assumed to be 100% for batches (all batches are examined). *At the batch level*, the prevalence of disease estimated by expert opinion is used to determine batch sensitivity and the number of birds examined per batch was assumed to be 50.

Coverage	Bird-level		Batch-level
	1%	10%	100%
HPAI	0.39%	3.89%	99%
Newcastle	0.35%	3.47%	95%
Coliform cellulitis	0.43%	4.30%	82%
MG	0.52%	5.20%	95%
Colisepticaemia	0.73%	7.30%	88%
Botulism	0.00%	0.00%	98%
Necrotic enteritis	0.67%	6.73%	96%
Avian tuberculosis	0.48%	4.85%	96%
Egg peritonitis	0.32%	3.25%	72%
Duck plague	0.71%	7.10%	100%
IBD	0.44%	4.44%	94%
Aspergillosis	0.61%	6.07%	87%
Histomoniasis	0.48%	4.80%	97%
Thermal discomfort	0.61%	6.06%	92%
DOA	0.00%	0.00%	90%
Injuries	1.00%	9.95%	100%
Pododermatitis	0.20%	1.99%	75%
Skin lesions	1.00%	10.00%	94%
Tarsal dermatitis	1.00%	9.97%	88%
Ascites	1.00%	10.00%	97%

Key points:

- The detection fraction at the bird level is low, because of the low coverage. In other words, the meat inspection systems have a poor capacity to identify all individual cases of disease at the animal level. In contrast, if the unit of interest is the batch (referring back to the farm of origin), the ability to detect every case of an affected/infected batch is generally high, because each batch is examined.

- For case detection, risk-based increase in examination of birds would result in both higher animal- and batch-level detection fractions for those batches identified as high risk.

2.3.2.2. Stage 3 modelling

a. Detection probabilities for epidemic diseases in the overall surveillance system

Table 6 presents the estimated animal- and batch-level detection probabilities for avian influenza in broiler turkeys (11-20 weeks) for each of three components of the overall surveillance system, based on the results of scenario tree modelling. Avian influenza[51] was used as an example of an epidemic disease. For each surveillance system component (abattoir surveillance [which includes both *ante*- and *post-mortem* inspection], clinical suspicion and serology), the estimated batch-level detection probability was 100%. Based on these modelling results, a range of different and equally effective surveillance components are available to detect avian influenza in broiler turkeys.

Table 6: Estimated animal- and batch-level probability of detection of broiler turkeys (11-20 weeks) with typical signs of avian influenza for each of three components of the overall surveillance system, based on the results of scenario tree modelling from *the COMISURV model*.

Surveillance systems component (SSCs)	**Detection Probability**	
	Animal level	Batch-level (10,000 – 30,000 birds)
Abattoir surveillance (SSC1)	0.0103	1.0
Clinical surveillance (SSC2)	0.0017	1.0
Serology (SSC3)	0.0245	1.0
Combined*	0.0361	1.0

These results are based on the assumption that 10,000 birds are examined with each system. In practice, much smaller numbers per batch would normally be involved in serological sampling, somewhat smaller numbers in abattoir inspection and larger numbers may be involved in on-farm clinical inspection. Therefore, to examine the effect of different sample sizes for different components of the surveillance system, the sample size required to achieve 90% sensitivity for each component (resulting in a 99.9% sensitivity for all components combined) are show in Table 7.

Table 7: The sample size (*n*) required for each of the three surveillance system components for avian influenza to achieve a surveillance sensitivity of 90%, based on the results of scenario tree modelling from *the COMISURV model*.

Surveillance system component	***n***
Serology	93
Clinical surveillance	2,200
Abattoir surveillance	298

Key points:

- Abattoir meat inspection provides equal sensitivity to the other surveillance system components when at least 300 animals are inspected per batch.

[51] At stage 3, data were not specific to High Pathogenic Avian Influenza but also referred to Low Pathogenic Avian Influenza

The sensitivity achieved by the different components for hypothetical sample sizes (intended to reflect a typical situation) are shown in Table 8.

Table 8: Sensitivity achieved by different hypothetical sample sizes for the different surveillance system components for avian influenza, based on the results of scenario tree modelling from *the COMISURV model*.

Surveillance system component	*n*	Sensitivity
Serology	50	71%
Clinical surveillance	10,000	100%
Abattoir surveillance	200	79%
Total		100%

Key points:

- Clinical surveillance of a flock (involving a large number of animals) is likely to be more sensitive and less costly than serological testing. In order to provide equivalent sensitivity, abattoir meat inspection would need to examine approx. 200 numbers of individual birds per batch.

- For epidemic poultry diseases/conditions, several different surveillance components are often available (for avian influenza, these include abattoir surveillance, clinical surveillance and serology). Based on model results (with underlying model input and assumptions), all three of these surveillance components are equally effective in detecting avian influenza in turkey broiler batches.

b. Detection fractions for endemic diseases in the overall surveillance system

Table 9 is based on outputs of the COMISURV model, with an underlying assumption that abattoir surveillance is based on inspection of every bird at slaughter, with a sensitivity of detection for each bird as outlined in Table 1. This may be unrealistic; therefore, the Table 9 results need to be interpreted with care.

Table 9 presents the estimated detection fraction at batch-level of four endemic diseases/conditions (aspergillosis in adult turkeys; septicaemia, IBD and ascites in broiler chickens 5-12 weeks) during abattoir inspection (SSC1; surveillance system component 1) and clinical suspicion (SSC2; surveillance system component 2), and the incremental benefit of SSC1 over SSC2 and vice versa, based on the results of scenario tree modelling.

The estimated quality of surveillance during abattoir surveillance, as measured using the detection fraction, varied by disease/condition. The detection fraction was 100% for septicaemia and IBD, 84.9% for ascites and 4.9% for aspergillosis. Alternative surveillance components are available for each of these four diseases/conditions. Based on the model results, there were differences in the relative contribution of meat inspection to the overall surveillance system. Alternative effective surveillance components to meat inspection (those surveillance components with a similar estimated detection fraction as meat inspection) are available for septicaemia and IBD, but not for aspergillosis and ascites. Therefore, for two of the four modelled endemic diseases/conditions, this is currently no effective surveillance alternative to meat inspection.

Table 9: Estimated detection fraction for four endemic diseases/conditions (aspergillosis in adult turkeys; septicaemia, IBD and ascites in broiler chickens 5-12 weeks) during abattoir surveillance (SSC1; surveillance system component 1) and clinical surveillance (SSC2; surveillance system component 2), and the incremental benefit of SSC1 over SSC2 and vice versa, based on the results of scenario tree modelling from *the COMISURV model.*

Disease/ welfare condition	**Detection fraction**			
	Individual surveillance system component		Incremental benefit	
	Abattoir inspection (SSC1)	Clinical inspection (at farm) (SSC2)	SSC2 over SSC1	SSC1 over SSC2
Aspergilosis	0.049	0.001	0.001	0.049
Septicaemia	1.0	1.0	0.0	0.0
IBD	1.0	0.962	0.0	0.038
Ascites	0.849	0.021	0.0003	0.831

Key points:

- Table 9 is based on outputs of the COMISURV model, with an underlying assumption that abattoir surveillance is based on inspection of every bird at slaughter, with a sensitivity of detection for each bird as outlined in Table 1. This may be unrealistic; therefore, the Table 9 results need to be interpreted with care.

- The value of meat inspection as a surveillance method varied by disease/condition. The estimated detection fraction was very high for septicaemia, IBD, high for ascites but very low for aspergillosis.

- Based on model results (with underlying model input and assumptions), either meat inspection or clinical suspicion could be used for surveillance of two of the four endemic poultry diseases/conditions. However, no effective surveillance alternative to meat inspection was available for either ascites or aspergillosis.

2.3.3. Additional comments

As outlined in the COMISURV report, parameters for the probability of typical case detection (detection nodes) are based on expert opinion. These experts had significant experience in meat inspection, avian pathology and welfare, and the information elicited was related to the biology of the disease/conditions under consideration and considered to be representative for all regions of Europe. However, as outlined in greater detail in this report, there is uncertainty as to the true range of these values. The number of experts was limited and not all of them were familiar with the planned models and how their input would contribute.

Model outputs in this report are, for simplicity, presented as single figures, which represent the expected value of the output distributions. In some cases, due to uncertainty, the output distributions are relatively wide. However, as values approach 100%, the width of the output distribution narrows.

The modelling was constrained by a lack of published data, as outlined in the COMISURV report, noting that considerable data are required to parameterise the detection fraction model and different risk-based surveillance scenarios. Published data about within-flock prevalence were scarce, requiring estimates to be made by the participating experts on the likely proportion of infected birds in an affected batch at slaughter. Similarly, for some diseases (avian tuberculosis, necrotic enteritis), flock prevalence was available at the level of the slaughterhouse, but not the farm. (Design) assumed within flock prevalence for epidemic diseases was fixed, based on EU reports. As suggested in the report, further epidemiological research should be conducted in order to obtain true between and within-flock prevalence for the diseases/conditions of interest.

In both *the COMISURV model* and *the simplified model*, independence between *post-mortem* inspection steps is assumed. This assumption would hold in those abattoirs where each inspection step is undertaken by different personnel. In such situations, the steps are independent, as the inspector at one point is not aware of the finding at another, so cannot be influenced by them. If one person is doing multiple steps, then the steps may not be independent (knowing about *ante-mortem* problems may increase the sensitivity of *post-mortem* inspections).

- In *the simplified model*, surveillance information has been generated at the level of the batch. In other words, output estimates from the model are made at the level of the batch, based on an analysis of bird-level observations. An assumption of independence between batches is therefore not required, as the unit of interest is the batch, and conclusions are being made at the batch level.

3. Implications for surveillance and monitoring for poultry health and welfare of changes to meat inspection as proposed by CONTAM

The CONTAM report presents a broad range of additional conclusions and recommendations, with particular emphasis on:

- The ranking of chemical substances, with dioxins, dioxin-like polychlorinated biphenyls, chloramphenicol, nitrofurans and nitroimidazoles being ranked as being of high potential concern.

- Sampling for chemical residues and contaminants in poultry should be based on the available food chain information (FCI).

- Better integration of control programmes with feed controls, with these programmes being regularly updated in order to include new and emerging substances.

Most of the CONTAM conclusions and recommendations have limited impact on animal health and welfare surveillance and monitoring. However, several are of relevance. Specifically, the CONTAM report highlights the need for incorporation of food chain information and questions the value of visual meat inspection. These are reflected below, in selected CONTAM conclusions and recommendations:

- Chemical hazards are unlikely to be detected by clinical observation of a flock at farm level or by visual *ante-/post-mortem* meat inspection at the slaughterhouse *(Conclusions, CONTAM)*

- The contribution of visual clinical *ante-mortem* inspection of a flock and of *post-mortem* inspection of the carcasses is of limited value for the identification of chemical hazards. Therefore, control of undesirable or hazardous chemicals in poultry, in the context of current meat inspection, depends almost entirely on the samples taken and analyzed for residues and contaminants *(Conclusions, CONTAM)*

- Sampling of poultry should be based on the available Food Chain Information (FCI) *(Recommendations, CONTAM)*

- The regular sampling and testing for chemical residues and contaminants is a disincentive for the development of undesirable practices *(Conclusions, CONTAM)*

- Any new methods of meat inspection and related sampling and testing should include, in addition to the recognised strengths of the current system, consideration of animal husbandry and FCI, and better integration of feed control with chemical residues and contaminants monitoring *(Recommendations, CONTAM)*

The above-mentioned conclusions and recommendations are similar to those raised in the BIOHAZ report (as outlined in section 2.), with equivalent implications for surveillance and monitoring of poultry health and welfare.

4. Conclusions and recommendations

Conclusions and recommendations in AHAW meat inspection poultry

4.1. Overview of the current situation (section 1.1)

Conclusions:

- The current poultry meat inspection system, both *ante*- and *post-mortem*, is valuable for maintaining a reliable food supply and for good animal welfare and disease management.

4.1.1. Animal health (section 1.1.4)

Conclusions:

- In meat inspection of poultry, the epidemiological unit of interest is generally at the level of the flock or batch, rather than the individual animal, which influences the design and implementation of surveillance activities.

- Although some poultry diseases have been decreasing in frequency due to effective control methods, some have re-emerged due to new management or production systems, and new disorders or pathogens have also appeared. Meat inspection is often a key point for identifying outbreaks of existing or new disorders or disease syndromes.

4.1.2. Animal welfare (section 1.1.5)

Conclusions:

- Animal-based welfare-outcome indicators have been developed for use on farm and at the abattoir for laying hens and for chickens and other poultry kept for meat production. These include hock-burn, foot-pad dermatitis, ascites, bruises, broken bones and deaths.

- In the course of normal commercial procedures, *ante*- and *post-mortem* inspection of poultry is an appropriate and practical way to evaluate the welfare of poultry on-farm, and the only way to evaluate the welfare of poultry during transport and associated handling. In relation to welfare during transport, *ante-mortem* inspection is important to detect mortality prior to slaughter and birds with major fractures.

4.2. Qualitative assessment

4.2.1. Removal of visual post-mortem inspection (section 2.2.2.1.)

Conclusions:

- Currently, approximately 1-2% of poultry carcasses are condemned, predominantly due to endemic disease and welfare conditions, and are prevented from entering the human food chain. Few of these diseases and conditions can be identified during on-farm inspection.

- There are two key consequences of omission of visual *post-mortem* inspection on surveillance and monitoring for poultry health and welfare:

  - Current opportunities for data collection during visual *post-mortem* inspection will be lost, with the concomitant loss in information about the occurrence of existing or new disorders or disease syndromes of poultry in particular due to the loss of information from examination of condemned carcasses. Information on the occurrence of several important welfare problems will also be lost because many of those conditions can only be identified during post-mortem inspection at the abattoir.

  - There is the potential for carcasses with pathological changes, currently condemned and recorded during visual *post-mortem* inspection, to be further processed without the infectious nature of some conditions being detected. With respect to these carcasses, it is not known if the meat quality assurance system, as proposed, will achieve an equivalent sensitivity of detection as traditional visual meat inspection.

- In the absence of a system of visual *post-mortem* inspection, a process will be needed to ensure the removal of all abnormal carcasses with visible pathological changes or other abnormalities. Important information for disease management and for evaluation of welfare is obtained by the careful inspection of these carcasses by a qualified person.

Recommendations:

- If *post-mortem* inspection is changed, other approaches should be explored and applied to compensate for any associated loss of information on the occurrence of endemic diseases and other welfare conditions.

- Post-mortem checks should continue to be such that there can be removal from the slaughter line of each carcass unsuitable for human consumption due to visible pathological changes or other abnormalities. In order not to lose an important tool for information on animal health and welfare, qualified person should continue to examine those carcasses and a proportion should be subject to careful inspection in order to obtain information for disease management and for evaluating animal welfare.

- There should be specific *post-mortem* surveillance and monitoring for those welfare conditions that only can be identified during *post-mortem* inspection at the abattoir.

- The meat inspection framework should be adapted, as required, to changes in the epidemiological situation of current hazards and the emergence of new hazards. In cases of an epidemic disease alert, it should be possible to carry out a sufficiently detailed *post-mortem* inspection for targeted and risk based surveillance, including condemned birds.

4.2.2. Incorporating food chain information (section 2.2.2.2)

Conclusions:

- Extended use of FCI has the potential to compensate for some but not all of the information on animal health and welfare that would be lost if visual *post-mortem* inspection were removed. This can only occur if the FCI is designed to identify indicators for the occurrence of animal health and welfare disorders.

- FCI for public health purposes may not have an optimal design for surveillance and monitoring of animal health and welfare. Indeed, FCI directed to major zoonotic agents, such as *Salmonella* and *Campylobacter* which do not usually result in clinical disease in poultry, are likely to be of minor importance for surveillance and monitoring of animal health and welfare.

- FCI directed to identify indicators of animal health and welfare disorders with high risk of condemnation of carcasses at slaughter may have limited importance for public health. However, FCI may be used to determine additional inspection procedures for animals or group of animals to monitor specific animal health and welfare issues.

- As yet, only a limited number of studies have been conducted in Europe to evaluate the value of FCI in the context of surveillance and monitoring for poultry health and welfare.

Recommendations:

- FCI should include information about both poultry health and welfare.

- An integrated system should be developed where FCI for public health and for animal health and welfare can be used in parallel.

4.2.3. Opportunities, in light of the proposed changes (section 2.2.2.3)

Conclusions:

- An additional system will be needed to compensate for a loss of surveillance and monitoring information following the removal of visual post-mortem inspection of all birds. It is proposed that this is achieved through detailed inspection of a defined subset of carcasses from each batch, guided by FCI and other epidemiological criteria, to obtain information for disease management and for evaluating animal welfare. The intensity (number of birds sampled) of targeted surveillance within each batch would be risk-based, with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch.

- If used optimally, FCI can be a valuable tool, and an economic incentive, to minimise the costs associated with the estimated 1-2% condemnation rate. A reduction in the condemnation rate of poultry at slaughter will prevent associated flock health and welfare problems during production.

- Poultry health and welfare monitoring and surveillance system is reliant on a robust two-way information flow between farm and abattoir.

- The current feedback of relevant animal welfare and health data to farms of batches that were slaughtered can be used as broad measures of flock health and welfare.

- An extended use of FCI in the meat inspection process offers opportunities for an integrated use of animal-based welfare-outcome indicators, which the European Commission currently aim to use to check on the welfare of poultry and other farmed species, both on-farm and

during transport. Their use will require data collection *ante-* and *post-mortem*, in some cases on all animals and in other cases on samples of animals.

- Systems of feedback from abattoir to farm are important, and can be further improved. More research and demonstration are needed on the integration of FCI for poultry surveillance and monitoring for welfare and disease management, including FCI that is most relevant for this purpose. Studies should investigate a range of outcomes, in addition to condemnation.

Recommendations:

- Research and demonstration should be conducted on the integration of FCI for poultry surveillance and monitoring for welfare and disease management. Studies should investigate the link between FCI for public health and for poultry health and welfare, and a range of outcomes, in addition to condemnation.

4.3. Quantitative assessment

4.3.1. Stage 2 modelling

Conclusions:

- Meat inspection, as currently practiced, is not equally effective in detecting different diseases/conditions of poultry.

- *Ante-mortem* inspection alone (if used correctly) has a relatively high probability of detecting most diseases and conditions in infected batches.

- The batch-level sensitivity is very dependent on the assumed within batch prevalence and the number of birds examined per batch. Batch-level detection probability increases with increased number of birds examined. An increase in sample size (that is, the number of birds sampled for more intensive meat inspection), as could occur with increased use of food chain information, will result in a higher batch-level sensitivity of meat inspection (for a given within batch prevalence) or the ability to detect lower levels of disease (at a given batch-level sensitivity).

Recommendations

- Guidance should be provided on the application of targeted surveillance during meat inspection of poultry. The intensity (number of birds sampled) of targeted surveillance within each batch should be risk-based, with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch. The number of examined birds per batch should be justified and based on scientific data relating to the epidemiological situation, including within-batch prevalence, batch size, and bird-level detection sensitivity.

4.3.2. Stage 3 modelling

Detection probabilities for epidemic diseases in the overall surveillance system
Conclusion:

- For epidemic poultry diseases/conditions, several different surveillance components are often available (for avian influenza, these include abattoir surveillance, clinical suspicion and serology). Based on model results (with underlying model input and assumptions), all three of these surveillance components are effective in detecting avian influenza in turkey broiler batches.

- Clinical surveillance of a flock (involving a large number of animals) is likely to be more sensitive and less costly than serological testing for early detection of epidemic diseases of poultry. In order to provide equivalent sensitivity, abattoir inspection would need to examine large numbers of individual birds per batch.

Detection fractions for endemic diseases in the overall surveillance system
Conclusions:

- The value of meat inspection as a surveillance method for endemic diseases and welfare conditions of poultry varies by disease/condition. Based on the model outputs, the estimated detection fraction was very high for septicaemia, IBD, high for ascites but very low for aspergillosis. However, these results need to be interpreted with care, given the underlying model assumptions.

- Based on the model outputs (with underlying model inputs and assumptions), either meat inspection or clinical suspicion could be used for surveillance of two of the four endemic poultry diseases/conditions. However, no effective surveillance alternative to meat inspection was available for either ascites or aspergillosis.

4.3.3. Additional comments (on modelling)

Conclusions:

- The quantitative model provides insights into detection probabilities during meat inspection and the relative contribution of meat inspection in the overall surveillance system.

- The model outputs need to be interpreted with care, given uncertainty with respect to model inputs and assumptions. Further, the quantitative methodologies are more complex in poultry than other species, in large part due to the multi-hierarchical nature of modern poultry production (in effect, the multiple levels of interest, including countries, compartments, zones, farms, flocks, batches, birds). Model inputs were primarily reliant on expert opinion, as relevant published data are scarce. The modelled probability of detection is based on a range of assumptions, including the number of birds inspected per batch and an assumption of independence between each inspection step. The inclusion of the model in the approach, however, is maintained for consistency across all species for meat inspection systems.

- The conclusions from the qualitative and quantitative assessments are generally congruent, providing insights into the surveillance value of meat inspection as currently practised, and the implications on poultry health and welfare surveillance if proposed changes were introduced.

Recommendations:

- It is recommended that epidemiological research is conducted to address data gaps relevant to the epidemiology of diseases/conditions of poultry in the EU, in particular those relating to flock and within-flock prevalence.

4.4. CONTAM (section 3)

Conclusions:

- The CONTAM conclusions and recommendations have limited impact on animal health and welfare surveillance and monitoring.

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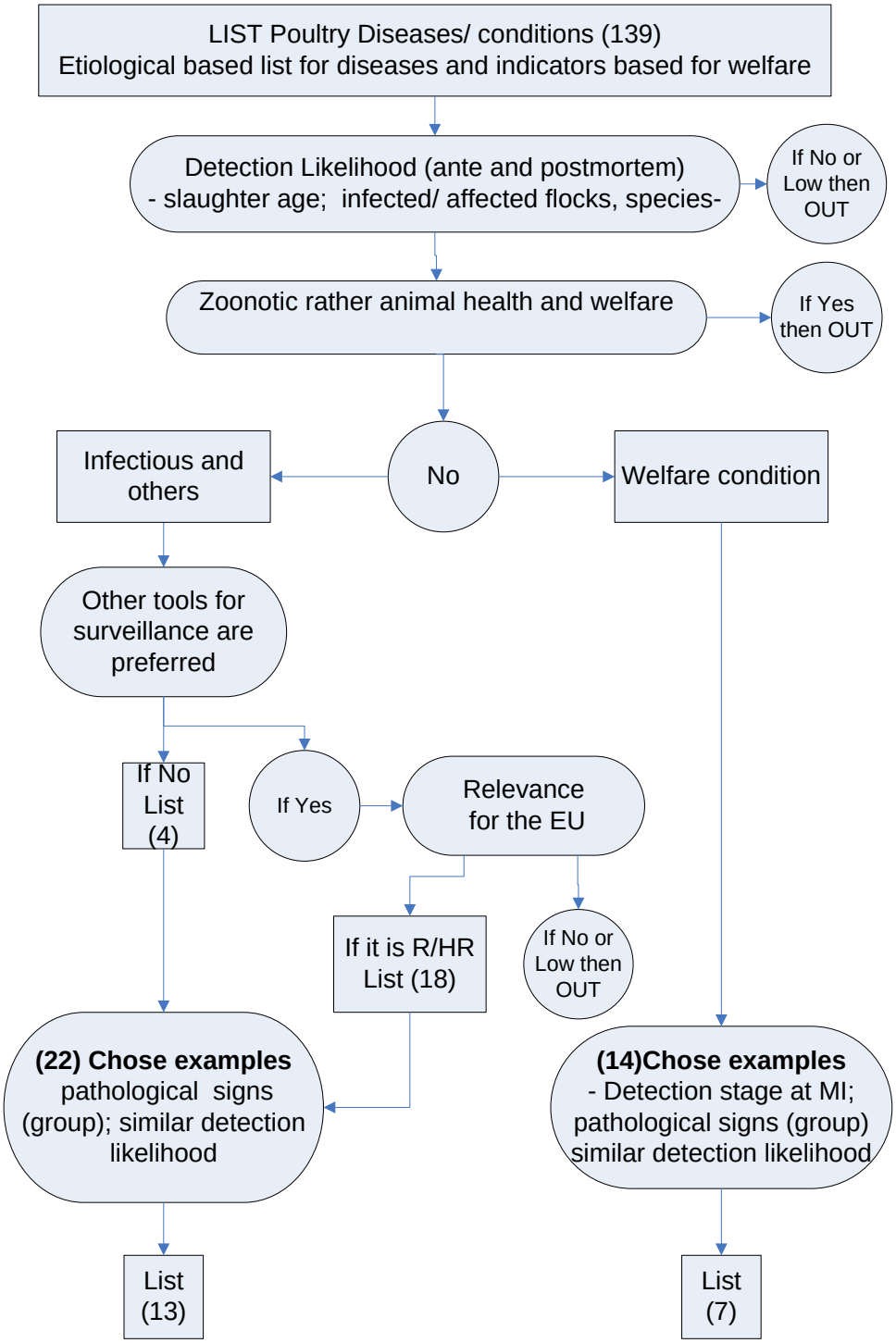
6. Annexes (AHAW)

A. Selection of diseases /conditions for modelling (stage1)



Selection for Stage 2 modelling

BACTERIAL DISEASES (12) (7)

1. Coliform cellulitis (*E. coli* dermatitis) and *Clostridium perfringens* - Gangrenous dermatitis (malignant oedema, cellulitis) (dermatitis)
   Main species and age: chickens aged 2-5 wks (broilers)
2. *Avibacterium paragallinarum* infection –infectious coryza (adult chickens) (previously *Haemophilus*),*Ornithobacterium rhinotracheale* infection Main species and age: chickens and turkeys, immature birds most commonly affected, *Mycoplasma gallisepticum* - Avian mycoplasmosis (as example)Affects several species and all age categories (respiratory pathology). For modelling chose chickens at young age
3. Colisepticaemia (septicemic)
   Chickens aged 2-12 wks. Modelling in Stage 3, passive surveillance, necropsy after farmer notification
4. *Clostridium botulinum* (botulism, limberneck) (antemortem)
   Affects several species and all age categories. For modelling chose chickens at young age chickens aged 2-5 wks (broilers)
5. *Clostridium perfringens* (necrotic enteritis and hepatic disease) (only a few countries are targeting inspection for the hepatic condition)
   Chickens aged 2-12 wks. (broilers)
6. *Mycobacterium avium subsp. avium* - Avian tuberculosis (notifiable disease , early detection)
   Main species and age: adult chickens
7. Egg peritonitis (*E. coli*)
   adult (sexually mature female) chickens (laying hens and breeder birds).

Fowl cholera (septicemic not common but may become more important, notifiable if combined with high mortality)

Erysipelothrix rhusiopathiae – erysipelas (septicemic, not common but may become more important)

VIRAL DISEASES (7) (4)

8. Duck virus enteritis (Duck plague)
   ducks, all ages affected, but higher mortality in adults than in immature birds
9. Newcastle disease
10. *Orthomyxoviridae* –Influenza HPAI- Avian influenza
    Main species and age: Affects a large number of species and all age categories. For modelling: I would use chickens or turkeys. Modelling in Stage 3, other SSC available, active and passive surveillance
11. *Birnaviridae* – Infectious bursal disease
    Main species and age: chickens, young age (2) 3-6 wks. Most cases occur prior to slaughter, but sometimes the disease is diagnosed at slaughter (very short incubation period). Important to do this to avoid further spread of virulent virus striains.

Marek's disease virus - Marek's disease (more likely to be detected earlier, not all forms are detectable)

Leukosis/sarcoma group and Reticuloendoteliosis (more likely to be detected earlier, not all forms are detectable).

Potential to be included in the list of 20 (stage 2) but very suitable for stage 3.

FUNGAL DISEASES (1)

12. Aspergillosis (brooder pneumonia)
    Main species and age: turkey, clinical disease predominantly in young birds (aged 0-3 wks) but subclinical aspergillosis is an important and rather common cause of condemnation at slaughter that would go undetected if not recorded at slaughter

PARASITIC DISEASES (1)

13. Histomoniasis (blackhead)
    Main species and age: turkey, immature birds

WELFARE CONDITIONS (14) (7)

14. Dead on arrival (death during transport) (ante-mortem/high)
    all species and ages, for modelling broilers could be the choice (most numerous species)
15. Thermal discomfort during transport and lairage (*ante-mortem*/medium)
    Main species and age: all species and ages, for modelling broilers could be the choice (most numerous species)
16. Traumatic injuries (broken limbs, dislocation of hip and other joints, haemorrhages) as a consequence of poor genetics and on farm management (ante-mortem or hanging stage or later /high detection)
    all species and ages, for modelling broilers could be the choice (most numerous species)
17. Pododermatitis (hanging stage or later /high detection if done well)
    Main species and age: chickens (broiler)
18. Skin lesion/ scratches/abcesses /pecking (including vent pecking)/mating injuries (hens, puncture wounds on body) (hanging stage or later /high detection if done well)
    Main species and age: chickens. Age depends on type of lesion: e.g., scratches most common in broilers, pecking in adult layers, and mating injuries in breeder birds
19. Tarsal dermatitis (hanging stage or later /high detection if done well)
    Main species and age: chickens (broiler)
20. Ascites (post-mortem/high detection)
    Main species and age: chickens (broilers)

Cachexia (hanging stage or later /high detection)

Bumble foot (hanging stage or later /high detection if done well)

Breast burn and Breast blister (post-mortem/high detection)

Rotational (torsional) and angular (valgus/varus) deformity (hanging stage or later /high detection if done well)

Selection for Stage 3 modelling

Ascites (SSC – passive surveillance, after farmers notification) Could be but the information is no going to the slaughter house

Traumatic injuries (cancelled because no other SSC) there are detection of injuries at farm but at slaughterhouse detection is mainly on the injuries pre- and during transport Or to use adaptation of modelling for the WF issues –(e.g. prevalence estimation, there are some passive surveillance at farm on traumatic injuries but the birds are removed before slaughtering, at slaughtering are detected cases happened or during transport, it will be a bias in the population and cases)

Dead on arrival (cancelled because no other SSC)

Aspergillosis (SSC – passive surveillance, after farmers notification) Could be but the information is no going to the slaughter house

Infectious bursal disease (SSC – passive surveillance, after farmers notification) Could be but the information is no going to the slaughter house

To add in Stage 3

Colisepticaemia (septicemic) (SSC – passive surveillance, necropsy, after farmers notification)

Orthomyxoviridae –Influenza HPAI- Avian influenza (SSC – passive surveillance, after farmers notification and programs for active surveillance in EU)

B. Literature search

(search in ISI Web of Knowledge in January 2012)

animal species
(poultr* OR bird$ OR chick* OR duck* OR gees*)
bantam OR Broiler OR capon OR chick* OR cock OR coturnix OR duck OR fowl OR "Gallus gallus" OR geese OR hen OR poult OR poultry OR quail OR turkey

No wild cards because of using lemmatisation=on (in ISI Web it is done by the system; contrary, if we turn off this option, we will need wild cards.

AND

Place of control / inspection
(slaughter OR (meat AND inspection) OR abattoir)

AND

General scope
(health OR Welfare)

AND

(Specific scope
(Surveillan* OR monitor*)
prevalence OR incidence OR seroconversion OR infection OR epidemiology OR outbreaks OR surveillance OR monitoring OR detection

OR

Significance
(impact* OR magnitu*))

<< Back to previous page

Results Topic=(bantam OR Broiler OR capon OR chick* OR cock OR coturnix OR duck OR fowl OR "Gallus gallus" OR geese OR hen OR poult OR poultry OR quail OR turkey) AND Topic=(slaughter OR (meat AND inspection) OR ante* OR post* OR abattoir) AND Topic=(health OR Welfare) AND Topic=(prevalence OR incidence OR seroconversion OR infection OR epidemiology OR outbreaks OR surveillance OR monitoring OR detection)
Refined by: Topic=(impact* OR magnitu*)
Timespan=All Years.
Lemmatization=On

Note: Alternative forms of your search term (for example, tooth and teeth) may have been applied, in particular for Topic or Title searches that do not contain quotation marks around the terms. To find only exact matches for your terms, turn off the "Lemmatization" option on the search page.

Results: **148**
Very limited number of papers (5) fit in the scope of the poultry meat inspection AHAW

Follow up of the results: the expert of the working group provided expertise and scientific articles on the specific points identified in the scientific discussions.