CA18105 - Risk-based meat inspection and integrated meat safety assurance (RIBMINS)
WG5 deliverable

Working Group 5 - Meat safety assurance system training, communication and monitoring

DELIVERABLE 5.2

Manual for training of participants in future meat safety assurance system

Editors assembling and summarizing materials pertaining to the different RIBMINS working groups:

WG1: Eduarda Gomes-Neves, Brigita Hengl
WG2: Brigitte Sperner, Claudia Guldimann
WG3: Maurizio Ferri
WG4: Madalena Vieira-Pinto, Nina Langkabel, Boris Antunovic
WG5: Claudia Guldimann, Sophia Johler

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Introduction

More than a decade ago (2013), EFSA proposed a novel, risk-based meat safety assurance system (RB-MSAS) that aims to address the latest, most relevant meat-borne hazards and to protect human as well as animal health and welfare. Advantages of this new framework for meat safety lie in the combination and longitudinal integration of prevention and control measures along the meat production chain. It also resulted in amendments to relevant EU legislation between 2014-2019. However, the state of implementation of RB-MSAS varies greatly among European countries, as do the training opportunities for official veterinarians (OVs) that are available.

The COST Action on risk-based meat inspection and integrated meat safety assurance (RIBMINS, https://ribmins.com/) ran between 2019-2023 with the aim to combine and strengthen Europe-wide research efforts in the modernization of meat safety control systems.

RIBMINS was a network of more than 270 scientists from 36 European countries, as well as participants from the USA, Australia, New Zealand and Brazil. It was funded by the European Cooperation in Science and Technology (COST).

Within RIBMINS, five different working groups were dedicated to different areas of risk-based meat safety: (i) scope & targets of meat safety assurance, (ii) farm-level controls & risk categorization, (iii) abattoir level controls & risk categorization, (iv) impact of changes & alternatives to traditional meat inspection, and (v) meat safety assurance system training, communication and monitoring. Three training schools were held within the framework of RIBMINS, all of which are accessible for free online. In addition, a substantial number of publications have resulted from the combined efforts of these working groups, many of which are relevant to the training of the future generation of OVs who are expected to take a leading role as risk managers within RB-MSAS systems. In this document we deliberately highlight publications that we deemed useful as training materials. For a full list of all publications that were published within the framework of RIBMINS, please refer to https://ribmins.com/reports-publications/

The aim of this document is to make the output of RIBMINS accessible to training needs for OVs in a concise form. It gives an overview of materials that can be used for training and continuing education of OVs and other risk managers in the field of RB-MSAS. It is not meant to be a textbook, but a guidance document that links to useful resources.

WG1: Scope & targets of meat safety assurance

Main topics

- Shaping the future discussions in the EU and globally on the modernisation of meat safety assurance by providing an evidence base to enable EFSA WGs and panels to form risk assessment opinions on meat safety assurance system (MSAS).
- Shaping the future discussions in the EU and globally on the modernisation of meat safety assurance by providing an evidence base to enable EFSA WGs and panels to form risk assessment opinions on meat safety assurance system (MSAS) and enabling EU Commission working groups to work on MSAS legislative framework for risk management.
- Determine and distinguish roles and responsibilities within the meat safety assurance system between OVs and risk managers in the meat safety assurance system, as well as to prioritise hazards and setting risk-related targets in the meat chain.

Publications & Conclusions

Report

Silvia Bonardi, Simone Belluco, Terje Elias, Martijn Bouwknegt, Elena Carrasco, Madalina Belous, Ioannis Sakaridis, Mati Roasto, Declan Bolton, Marjatta Rahkio, Aivars Berzins, Steve Hathaway, Ivar Vågstrom. 2023. Report on scope of meat safety assurance system and competencies and roles of risk manager. (https://ribmins.com/wp-content/uploads/2023/02/RIBMINS-WG1-Deliverable.pdf)

- A risk-based management system for meat safety necessitates real-time mitigation of risks stemming from the identified hazards. Limited data availability and resource constraints may pose challenges in conducting quantitative risk assessments at the level of food business operators (FBOs) or slaughterhouses. However, implementing risk ranking as a practical tool for FBOs and incorporating it into the MSAS could prove beneficial.
- The roles of the FBO risk manager and the competent authority (CA) risk manager are distinct, yet possess overlapping competencies. Collaboration between these two professionals is essential, but preventing any confusion regarding their respective tasks is important.
- The OV as a risk manager serves as a professional employed by the competent authority to ensure compliance with meat safety and animal welfare regulations. They utilize official controls to verify that FBOs effectively address food safety

concerns. The OV conducts periodic audits of specific components within the FBO's MSAS and gathers pertinent information for the national CA. The OV's responsibility includes ante- and post-mortem inspection certifying the suitability of meat for human consumption.

- Conversely, the risk manager working for the FBO assumes responsibility for managing meat safety concerns on behalf of the owner. Additionally, they oversee animal welfare matters and address all other quality issues associated with the wholesomeness of meat.

Papers

P1) Bojan Blagojevic, Truls Nesbakken, Ole Alvseike, Ivar Vågsholm, Dragan Antic, Sophia Johler, Kurt Houf, Diana Meemken, Ivan Nastasijevic, Madalena Vieira Pinto, Boris Antunovic, Milen Georgiev, Lis Alban. 2021. Drivers, opportunities, and challenges of the European risk-based meat safety assurance system. Food Control, 124:107870 https://doi.org/10.1016/j.foodcont.2021.107870.

Conclusions: European meat safety system revision and modernisation are activated by scientific advancements and the desire for cost-effectiveness within the livestock and meat industry. However, it is influenced by various political and socio-economic interests. The transition from a traditional system to a modern one is an evolutionary process rather than a revolutionary one. Therefore, it is a gradual and carefully guided undertaking, incorporating inputs from diverse stakeholders. This transition presents numerous opportunities to enhance public health in a cost-effective manner, but it also entails several challenges. It is evident that the continuous development and refinement of the risk-based meat safety management system (RB-MSAS) will be an ongoing journey rather than a fixed destination. The successful implementation relies on close collaboration among all stakeholders of the new system and necessitates extensive research to gather data and address knowledge gaps, alongside ongoing education and training efforts.

P2) Silvia Bonardi, Bojan Blagojevic, Simone Belluco, Mati Roasto, Eduarda Gomes-Neves, Ivar Vågsholm. 2021. Food chain information in the European pork industry: Where are we? Trends in Food Science & Technology. 118: 833-839
https://doi.org/10.1016/j.tifs.2021.10.030

Conclusions: Almost two decades have elapsed since the introduction of food chain information (FCI) through EU legislation, aiming to establish an evidence-based categorization of slaughter animals. However, discussions regarding the

deficiencies of FCI continue to persist today. Notably, countries like Norway, Sweden, Finland, Denmark, Germany, and Estonia incorporate harmonised epidemiological indicator (HEI) data into their FCI for incoming pigs, which is crucial for operating a risk-based meat safety management system (RB-MSAS). Nevertheless, this important element remains absent in most other countries. FCI should facilitate the seamless exchange of information on animal and public health hazards among all stakeholders involved in animal husbandry and meat production. The EU legislation currently lacks systematic pre-harvest/post-harvest controls for *Salmonella* spp., *Y. enterocolitica*, and *T. gondii*, necessitating discussions, drafting, and implementation of appropriate measures. Furthermore, modernization efforts incorporating high-quality FCI linked to herd health planning will not only enhance food safety but also deepen our understanding of the prevalence of these zoonotic agents within pig populations. Considering the significance of *Salmonella* spp. in food safety, the absence of harmonized national control programs at pre-harvest level in the EU and the failure to utilize HEIs in the FCI represent crucial gaps within the pork safety assurance system.

P3) Mati Roasto, Silvia Bonardi, Mihkel Mäesaar, Lis Alban, Eduarda Gomes-Neves, Madalena Vieira-Pinto, Ivar Vågsholm, Terje Elias, Lene Lund Lindegaard, Bojan Blagojevic. 2023. *Salmonella enterica* prevalence, serotype diversity, antimicrobial resistance and control in the European pork production chain. Trends in Food Science & Technology,131: 210-219, https://doi.org/10.1016/j.tifs.2022.12.007

Conclusions: *Salmonella* Typhimurium (ST), the monophasic *Salmonella* Typhimurium (MST) and *S.* Derby have been reported as the most prevalent *Salmonella* serotypes in the pork production chain in Europe, with a growing trend regarding MST. There are significant variations in the occurrence of *Salmonella* in the pig chain among European countries, with a tendency of lower *Salmonella* prevalence in countries implementing *Salmonella* control programs. This pattern exemplifies the significance and efficacy of the *Salmonella* containment measures in the pork production chain for reducing overall instances of human salmonellosis in Europe. Enhanced *Salmonella* management programs at pre-harvest (including feed control), harvest, and post-harvest stages of the pork production chain are required. In countries with a high prevalence of *Salmonella* in pigs, measures at both harvest and post-harvest levels are vital in reducing the occurrence of this zoonotic disease in humans. In conclusion, there is a necessity for *Salmonella* surveillance and containment programs in all European countries. In the pork production chain, a strategy incorporating a combination of multiple complementary control measures that are suitable and tailored to local epidemiological situations can provide satisfactory consumer protection.

WG2: Farm-level controls & risk categorization

Main topics

- Assessment of the effectiveness of pre-harvest meat safety interventions
- Assessment and improvements of Food Chain Information
- Risk categorisation of farms

Publications

Papers

P1) Joana Pessoa, Maria Rodrigues da Costa, Truls Nesbakken, Diana Meemken. 2021. Assessment of the Effectiveness of Pre-harvest Meat Safety Interventions to Control Foodborne Pathogens in Broilers: a Systematic Review. Current Clinical Microbiology Reports 8, 21–30. https://doi.org/10.1007/s40588-021-00161-z

> Conclusions: The main research focus on pre-harvest meat safety in broilers was on *Salmonella* spp. and *Campylobacter* spp. Biosecurity (pest control) and management measures aimed at improving hygiene resulted in mixed outcomes depending on the adequate implementation and combination of measures taken. Vaccinations were seen as an essential step towards the control of the most prevalent pathogens that should be part of a multi-pronged approach. Feed additives varied widely in their effect and their efficacy remains controversial.

P2) Maria Rodrigues da Costa, Joana Pessoa, Diana Meemken, Truls Nesbakken. 2021. A Systematic Review on the Effectiveness of Pre-Harvest Meat Safety Interventions in Pig Herds to Control *Salmonella* and Other Foodborne Pathogens. Microorganisms. 9(9):1825. https://pubmed.ncbi.nlm.nih.gov/34576721/

> Conclusions: *Salmonella* spp. was the main focus of the included studies on pre-harvest interventions in pigs. Feed and/or water treatments and vaccination were most effective for the prevention of *Salmonella* spp. Good management practices combined with high biosecurity levels resulted in high herd health status that effectively prevented most foodborne pathogens in pork at pre-harvest level. Other interventions that have been reported as feasible to control foodborne pathogens like *Salmonella* spp., *Y. enterocolitica* and MRSA include the SPF herd principle and stamping out and repopulating with disease-free animals.

P3) Maria Rodrigues da Costa, Joana Pessoa, Truls Nesbakken, Diana Meemken. 2023. A systematic review to assess the effectiveness of pre-harvest meat safety interventions to control foodborne pathogens in beef. Food Control,153, 109944. https://doi.org/10.1016/j.foodcont.2023.109944

> Conclusions: *Salmonella* spp. and STEC were the main focus of studies on pre-harvest interventions in bovines. Other pathogens may be better controlled at the post-harvest level. For *Salmonella* spp. and STEC, cleaning and disinfection, management measures, biosecurity and vaccination strategies were the most effective interventions, with studies showing the crucial effect of their correct implementation for their efficacy. As in other species, feed additives showed mixed results but seemed to be effective for *Salmonella* spp.. Overall, good management practices resulted in higher herd health status and were effective controls to prevent important foodborne pathogens in cattle at pre-harvest level.

P4) Susann Langforth, Verena Oswaldi, Rudi Isbrandt, Smaragda Sotiraki, Sofia Anastasiadou, Truls Nesbakken, Diana Meemken, Nina Langkabel: Food chain information for broilers: results of a Europe-wide survey on status quo, usability and suggestions for improvement. Food Control 152, 109844; https://doi.org/10.1016/j.foodcont.2023.109844

> Conclusions: The fact that the required food chain information for broilers is not well-specified within the EU regulations resulted in differences in the implementation of FCI for broilers between and within EU countries. In general, FCI were assessed to be useful for decision-making, especially in a digital format. Important data like ante- and postmortem inspection results was mostly available. Room for improvement was identified in areas such as information on diseases occurring on-farm with associated mortality data, data on treatment with veterinary medications; EFSA's harmonised epidemiological indicators and specific production data. Also, the survey showed that the measures to be taken in response to specific information were not well-defined. Specific steps to harmonize and consolidate FCI for broilers may include (i) specific legislation, (ii) electronic data exchange, (iii) close collaboration between decision-makers and operators, (iv) training of stakeholders and (v) abattoir-specific measures in response to FCI items.

P5) Ting-Ting Li, Diana Meemken, Boris Antunovic, Truls Nesbakken, Susann Langforth: Food chain information for broilers, pigs and bovines in Europe: Comparison of report forms and definitions of the relevant period for reporting treatments with veterinary medicinal products with withdrawal periods. Food Control 155, 110054, ISSN 0956-7135, https://doi.org/10.1016/j.foodcont.2023.110054

Conclusions: The EU regulations specify that food chain information should include information on veterinary medicinal products and other treatments that were administered to animals before slaughter. However, Regulation (EC) No 853/2004 does not specify the exact data to be collected, and there is considerable variation within the EU on what the relevant period for products with a withdrawal period should be. The survey showed that for broilers, the whole fattening period is considered relevant in most EU countries, while there is no consensus on the relevant period for pigs and bovines. Important next steps should include (i) harmonization of the entire fattening period as relevant for broilers, (ii) determination of the relevant period for pigs and bovines, also with regard to different rearing systems, and (iii) the implementation of electronic data exchange with supporting animal health databases.

P6) Nina Langkabel, Diana Meemken, Ting-Ting Li, Smaragda Sotiraki, Sofia Anastasiadou, Truls Nesbakken, Susann Langforth:
Use of harmonised epidemiological indicators (HEIs) for broilers in Europe. Food Control 154, 110020; https://doi.org/10.1016/j.foodcont.2023.110020

Broilers: As HEIs are only suggested by EFSA but are not legal requirements within the European Union (EU), it is unclear which HEIs are used in which country, so far. Therefore, an online survey was conducted in Europe to gather knowledge about the implementation, application and consequences following on from the HEIs in existing official and private monitoring and surveillance systems (MOSS). Additionally, the participants were asked if there is a need for additional MOSS.
For broilers, the identified HEIs focus on Salmonella, Campylobacter, ESBL/AmpC producing Enterobacteriaceae, and generic E. coli. All participants stated that testing for Salmonella is performed. Consequences that result from the existing MOSS for the three examined pathogens (Salmonella, Campylobacter and E. coli) were mainly rising awareness, farm categorisation and feedback to the farmer. In conclusion, according to the answers from participants from ten EU-MS, the HEIs suggested by EFSA for broilers are currently implemented in most countries. One reason could be that some of the according MOSS are required by EU law. As intended by EFSA, the participants stated that they use HEIs for farm categorisation as one of the three top consequences following from MOSS for the three mentioned pathogens. For improving the knowledge and application of HEIs in the context of risk-based meat safety assurance systems, specific training could be helpful.

P7) Ting-Ting Li, Susann Langforth, Nina Langkabel, Smaragda Sotiraki, Sofia Anastasiadou, Truls Nesbakken, Diana Meemken:

Implementation of harmonised epidemiological indicators (HEIs) for pigs – A Europe-wide online survey. Food Control 153, 109954; https://doi.org/10.1016/j.foodcont.2023.109954

> Conclusions: For pigs, a majority of the respondents from the official control and abattoir sector had implemented the HEIs that focus on Salmonella-, Trichinella- and Cysticercus cellulosae-monitoring and testing at abattoir level. These tests are required within meat inspection and mandatory by EU legislation. Except for Salmonella, all other HEIs for the same pathogens that focus on a different stage of the food chain were either not implemented at all or were implemented by less than 10% of the participants. This was also true for HEIs regarding other pig-associated hazards like Yersinia enterocolitica and Toxoplasma gondii. The results not only showed a lack of implementation of HEIs for pigs, but also revealed some concerning irregularities within the monitoring required by EU regulations. Several participants showed a lack of understanding with regard to diagnostic procedures for Salmonella, Yersinia enterocolitica, Toxoplasma gondii and Trichinella.

Training school

Farm and abattoir interventions in a risk-based meat safety assurance system - RIBMINS WG2/WG3 Virtual Training school (June 20th - 22nd, 2022). The main WG2 topics covered in this training school were:

- Kristin Ianssen: Actual and future challenges and needs from the farm level perspective (video link)
- Carla Gomes: Actual and future challenges and needs from the national perspective. Progress up to date on Salmonella controls in the EU (video link)
- Diana Meemken: Description of farm interventions (video link)
- Joana Pessoa: Systematic literature review on pre-harvest food safety interventions for broilers (proven efficacy by Randomised Controlled Trials) (video link)
- Maria Rodrigues da Costa: Systematic literature review on pre-harvest food safety interventions for pigs and cattle (proven efficacy by Randomised Controlled Trials) (video link)
- Truls Nesbakken: Pre-harvest food safety interventions (proven efficacy apart from Randomised Controlled Trials) (video link)
- Rhea Creve: BioCheck – Measuring biosecurity as a tool for zoonoses control (video link)

All videos and slides of the Training School can be found here: https://ribmins.com/training-school-on-farm-and-abattoir-interventions/

WG3: Abattoir level controls & risk categorization

Main topics

- Assessment of the available tools and methods for the detection of carcass contamination and current industry uptake in Europe
- Evaluation of the effectiveness of intervention strategies for the reduction (quantifiable level) of bacterial load on beef, pork, sheep, and poultry carcasses
- Assessment of harmonized epidemiological indicators in risk categorisations of abattoir
- Assessment of the performance of FSMS in abattoirs (topic also covered in online training school)

Publications & Conclusions

Reports

(R1) Report on methods and tools for the detection of carcass contamination and decontamination of animal skins and carcasses in abattoirs. Dragan Antic et al. 2021.

> Conclusions: The multiple-hurdle approach based on the sequential use of carcass interventions achieves higher reductions of bacterial contamination compared to single interventions, and is recommended to be used in abattoirs. However, for some interventions data is lacking and further investigation is required. Moreover, other contextual factors relevant to vision systems and interventions to inform the risk management decisions for RB-MSAS need to be taken into consideration.

Publications

(P1) Dragan Antic, Kurt Houf, Eleni Michalopoulou, Bojan Blagojevic. 2021. Beef abattoir interventions in a risk-based meat safety assurance system. Meat Science 182: 108622.

> Conclusions: To truly estimate the effect of interventions further research is needed, such as conducting more research under commercial conditions. Since some data are derived from multiple studies using different designs with a range of reduction effects reported, caution must be exercised when interpreting the efficacies of interventions and more statistical analysis need to be performed.

(P2) Nevijo Zdolec, Aurelia Kotsiri, Kurt Houf, Avelino Alvarez-Ordóñez, Bojan Blagojevic, Nedjeljko Karabasil, Morgane Salines, Dragan Antic. 2022. Systematic Review and Meta-Analysis of the Efficacy of Interventions Applied during Primary Processing to Reduce Microbial Contamination on Pig Carcasses. Foods. 2022 Jul 15;11(14):2110. https://pubmed.ncbi.nlm.nih.gov/35885353/

Conclusions: Scalding, singeing, washing with hot water and lactic acid, as well as dry chilling of pig carcasses, proved to be effective in reducing the counts of indicator bacteria. However, due to high heterogeneity among studies and the overall lack of large, controlled trials conducted under commercial conditions, more in-depth research is needed for evaluating the true efficacy of these interventions. Well-designed research condensed into meta-analysis studies, with results presented numerically and measures of variability would be useful. This information could corroborate further modeling and risk assessment studies, and guide FBOs in pig abattoirs on the use of specific and most effective interventions to reduce microbial contamination of carcasses and protect public health.

(P3) Simo Cegar, Ljiljana Kuruca, Bojana Vidovic, Dragan Antic, Sigrun J. Hauge, Ole Alvseike, Bojan Blagojevic. 2022. Risk categorisation of poultry abattoirs on the basis of the current process hygiene criteria and indicator microorganisms. Food Control 132: 108530. https://www.sciencedirect.com/science/article/pii/S095671352100668X?via%3Dihub.

Conclusions: Abattoir-based indicators and testing for pathogens resulted in different risk categorization. Therefore, other factors need to be investigated for a proper abattoir risk categorization. Moreover, indicators of microorganisms merit further standardization. To address these gaps and to corroborate risk categorization of poultry abattoirs more baseline studies on long-term series of indicators on chilled broiler carcasses are required along with their ideal combination with regular audits and parallel pathogen sampling.

(P4) Ivan Nastasijevic, Francesco Proscia, Marija Boskovic, Milica Glisic, Bojan Blagojevic, Simona Sorgentone, Andrej Kirbis, Maurizio Ferri. 2020. The European Union control strategy for *Campylobacter* spp. in the broiler meat chain. Journal of Food Safety: e12819. https://doi.org/10.1111/jfs.12819.

Conclusions: Proper implementation of extrinsic-proactive control measures (good manufacturing practice (GMP)/good hygiene practice (GHP)) at slaughter and dressing processing appears more effective in preventing cross-contamination of poultry carcasses and reducing the *Campylobacter*-associated human health risk compared to other measures. Hazard-based (or inherent) interventions that are reactive in nature, such as decontamination treatments, should be considered only as supplementary measures.

(P5) Morgane Salines, Thomai Lazou, Jose Gomez-Luengo, Janne Holthe, Ivan Nastasijevic, Martijn Bouwknegt, Nikolaos Dadios, Kurt Houf, Bojan Blagojevic, Dragan Antic. 2023. Risk categorisation of abattoirs in Europe: Current state of play. *Food Control* 152: 109863. https://doi.org/10.1016/j.foodcont.2023.109863.

Conclusions: Risk categorization of abattoirs is not sufficiently and clearly implemented by the majority of EU countries. Moreover, there is a problem of comparability of risk categorisation and risk reduction performance among abattoirs in Europe. GHP- and

hazard-based interventions like carcass dressing and animal selection methods are not considered as criteria in the currently implemented systems. Except for *Salmonella* (all species) and *Campylobacter* (poultry), there are no other foodborne pathogens included in the criteria, although they have been included by EFSA in the HEIs for the monitoring of carcasses (e.g., STEC in small ruminants). Current gaps in the system that need to be tackled by future research are a lack of formal assessment of the effectiveness of used methods, and the development of a science-based risk categorisation framework. The risk categorization is essentially used by the Competent Authority to adapt the frequency of official controls, and to provide a practical method for addressing the pertinent risks to public health.

Main conclusion

Abattoir risk categorization is based on risk reduction performance for priority pathogens, and is the outcome of an effective food safety management system implemented by the FBO. This requires farm-to-abattoir exchange of information, the use of HEIs, and the evaluation of the effectiveness of tools for detecting pathogens on carcasses as well as interventions to reduce their occurrence. Harmonization of risk categorization of European abattoirs is needed, with a focus on integration of HEIs and a science-based approach. Current methods mainly rely on visual assessment and to score practices or microbiological testing. Preventive and control measures of microbial contamination should be based on extrinsic intervention (GMP/ GHP) before and/or at slaughter, and on hazard-based interventions ideally developed from scientific research to achieve demonstrable and quantifiable reductions in hazard exposures. However, current challenges preventing implementation are the substantial differences among abattoirs that can affect their hygiene performances, and the wide range of different methods used in EU countries to assess process hygiene.

Training school

Farm and abattoir interventions in a risk-based meat safety assurance system - RIBMINS WG2/WG3 Virtual Training school (June 20th - 22nd, 2022). The main WG3 topics covered in this training school were:

- Winy Messens/Michaela Hempen: EFSA opinions on food/meat decontamination: Role of interventions in meat safety assurance systems (video link 1) (video link 2)
- Eystein Skjerve: Interventions in the meat chain: The need to integrate causal inference into planning of interventions (video link)
- Derk Oorburg: Actual and future challenges and needs from the slaughterhouse level perspective (video link)

- Dragan Antic: Physical abattoir interventions (lairage, GHP, thermal treatments) (video link)
- Kurt Houf: Chemical abattoir interventions and microbiological validation of interventions (video link)
- Dragan Antic: Results from ongoing WG3 work (interventions in beef, pigs, sheep, poultry) (video link)
- Mick Bosilevac: Hazard-based thermal and chemical interventions for beef and pigs: USA experience (video link)
- Catherine McCarthy: Quantitative MRA models for evaluating the effects of interventions in reducing risks for consumer (video link)
- Thiemo Albert: Abattoir interventions: novel treatments and non-thermal technologies (video link)

All videos and slides of the Training School can be found here: https://ribmins.com/training-school-on-farm-and-abattoir-interventions/

WG4: Impact of changes & alternatives to traditional meat inspection

Main topics

- Comparisons between the current and the future meat safety assurance systems
- Assessment of cost-effect of individual tools in the meat safety assurance system
- Updating meat inspection lesion codes to improve decision-making
- Redefining condemnation criteria to minimize food waste
- Efficacy studies to implement camera-based technology in meat inspection
- Harmonization of procedures to assess meat fitness for human consumption

Publications

Papers

P1) Ole Alvseike, Lis Alban, Miguel Prieto, Madalena Vieira-Pinto, Riikka Laukkanen-Ninios, Marianne Sandberg, Sergio Ghidini, Patric Maurer, Nina Langkabel, Diana Meemken, Jaime Gomez-Laguna, Susana Santos, Bojan Blagojevic. 2021. Safe meat obtained in easier ways. Moving towards a simpler method requires a collaborative and innovative approach from all stakeholders. Fleischwirtschaft International, 2, 38–41. https://english.fleischwirtschaft.de/service/epaper-FLEISCHWIRTSCHAFT-international-2_2021/

P2) Boris Antunović, Bojan Blagojević, Sophia Johler, Claudia Guldimann, Madalena Vieira-Pinto, Ivar Vågsholm, Diana Meemken, Ole Alvseike, Milen Georgiev, Lis Alban. 2021. Challenges and opportunities in the implementation of new meat inspection systems in Europe. Trends in Food Science & Technology. 116: 460-467. DOI: 10.1016/j.tifs.2021.08.002.

P3) Lis Alban, Madalena Vieira-Pinto, Diana Meemken, Patric Maurer, Sergio Ghidini, Susana Santos, Jaime Gómez-Laguna, Riikka Laukkanen-Ninios, Ole Alvseike, Nina Langkabel. 2021. Differences in code terminology and frequency of findings in meat inspection of finishing pigs in seven European countries. Food Control. 132: 1-13. 108394. ISSN: 0956-7135. DOI: 10.1016/j.foodcont.2021.108394

P4) Madalena Vieira-Pinto, Nina Langkabel, Susana Santos, Lis Alban, Jaime Gómez-Laguna, Bojan Blagojevic, Diana Meemken, Silvia Bonardi, Boris Antunovic, Sergio Ghidini, Patric Maurer, Ole Alvseike, Riikka Laukkanen-Ninos. 2022. A European survey on post-mortem inspection of finishing pigs: Total condemnation criteria to declare meat unfit for human consumption. Research in Veterinary Science. 152: 72-82. ISSN: 1532-2661. DOI: 10.1016/j.rvsc.2022.07.013

P5) Riikka Laukkanen-Ninios, Sergio Ghidini, Jaime Gómez-Laguna, Nina Langkabel, Susana Santos, Patric Maurer, Diana Meemken, Lis Alban, Ole Alvseike, Madalena Vieira-Pinto. 2022. Additional post-mortem inspection procedures and laboratory methods as supplements for visual meat inspection of finishing pigs in Europe – Use and variability. Journal of Consumer Protection and Food Safety. ISSN: 1661-5751. DOI: 10.1007/s00003-022-01391-z.

P6) Abbey Olsen, Silvia Bonardi, Lisa Barco, Marianne Sandberg, Nina Langkabel, Mati Roasto, Michał Majewski, Brigitte Brugger, Arja H. Kautto, Bojan Blagojevic, Joao B. Cota, Gunvor Elise Nagel-Alne, Adeline Huneau, Riikka Laukkanen-Ninios, Sophie Lebouquin-Leneveu, Ole Alvseike, Maria Fredriksson-Ahomaa, Madalena Vieira-Pinto, Eija Kaukonen. A comparison of European surveillance programs for campylobacter in broilers. Food Control, 2023, 110059, DOI: 10.1016/j.foodcont.2023.110059

Training school

Training school on future meat safety - RIBMINS WG4 Virtual Training school (February 3rd-5th, 2021). The main topics covered in this training school were:

- Lis Alban: Principles for risk-based surveillance and control - applications for relevance in meat safety, including benefit-cost methodology (video link)
- Sergio Ghidini: Overview and principles of meat inspection and hygiene legislation (video link)
- Lis Alban: Risk assessment related to replacement of traditional meat inspection with visual inspection only (video link)
- Ole Alvseike: Paradigms in meat safety assurance systems (video link)
- Ole Alvseike: Legislative needs, options, pro and cons (video link)
- Silvia Bonardi: Salmonella in the pork production chain in the EU (video link)
- Frank Boelaert: Risk management of Campylobacter (video link)
- Sergio Ghidini: Meat inspection codes – impact on risks, harmonisation, data analysis and feedback (video link)
- Lis Alban: Examples of risk-based meat inspection - tuberculosis and cysticercosis cases (video link)
- Silvia Bonardi: Harmonised epidemiological indicators (video link)
- Sergio Ghidini: Food chain information systems (video link)
- Maurizio Ferri: Future colleagues' profile (video link)

All videos and slides of the Training School can be found here: https://ribmins.com/training-school-on-future-meat-safety/

Conclusions

Current MSAS include, in addition to the ante and post mortem meat inspection, the already well-implemented approaches of HACCP, Good Hygienic Practices, Good Manufacturing Practices as well as surveillance and control programs. However, further developments in the field of IT, AI and sensor technology must be taken into account, and can be used in the field of food safety and pathology. WG4's vision is that in the future MSAS will provide food in a cost-efficient way that does not yet exist in Europe. Infrastructures can vary regionally, as local conditions as well as ownership and traditions play a role and have to be taken into account. However, the goal should always be to produce safe food according to the defined conditions with an adequate level of protection.

For indoor-raised pigs in Europe the transition process of introducing the new meat inspection systems is mainly implemented, but variations exist between different European countries. Hurdles that were identified cover the existing trade agreements with 3rd countries, costs of implementation, inadequate food chain information and resistance from meat inspectors. But stakeholders are more confident with the new systems and countries that have implemented new meat inspection systems reported reduced or equal workload related to the inspection compared to the traditional system.

Meat inspection codes are not harmonized in the EU. As an example, a study looking at code systems for pigs show that they vary in seven European countries regarding terminology, number of codes available, number of codes assigned per pig, and the way the codes in the list can be categorized. Official coding systems do not exist in all countries at a national level, sometimes missing entirely and sometimes existing only at the regional level. Because the total condemnation (TC) findings are differently defined in the countries, comparability is limited and variations may be related to the structure of the code system, the interpretation of the codes, or existing real differences in animal health. Not all 20 reasons for unfitness of pig meat given in the EU Food Inspection Regulation (EU) 2019/627 are reflected in the national code lists, and the individual codes could not always be linked to the EU condemnation reasons. The EU list focuses only on unfitness of meat for human consumption for food safety reasons and animal welfare codes, also leading to TC in some cases, are not included. A fully functional system would therefore warrant the inclusion of additional codes. A list of 40 new, aggregated codes was proposed and should be considered in a future discussion about more harmonized meat inspection. This would allow comparison between abattoirs and produce more meaningful data for the pig producers.

During post mortem inspection (PMI) of finishing pigs different combinations of lesions can be observed. In different national code lists, diverse TC criteria and practical instructions regarding judgment are in place but harmonization is lacking. Suggestions for identifying the findings that reflect a generalized condition of disease and to look at whether findings reflect an acute disease stage or not, can help. In general, the meat inspectors' judgment depends on the individual case

and it is important that some flexibility in judging meat unfit for human consumption exists. However, basic principles for the interpretation of post mortem findings should be harmonized. Visual-only PMI for finishing pigs is not applied in all European countries mainly due to export requirements. The most important reasons were findings in ante and post mortem inspection that often lead to performing additional post mortem meat inspection (APMI) procedures with a wide variety of use in different countries.

Main scientific gaps

- The reasons and level of APMI variation should be further investigated in order to harmonize risk-based meat inspection systems applied in the EU.
- To avoid unnecessary condemnation, further research should be carried out to clarify and define the basis for the evidence-based TC of pig carcasses affected by PMI findings detected at slaughter.
- Implementation of effective condemnation codes would result in meaningful data for the pig producers and would allow comparisons between abattoirs in a future discussion about more harmonized meat inspection.
- Use of new laboratory methods and technologies as APMI procedures to assist judgment of fitness for human consumption should be the focus of future research questions.
- Development of national guidelines for condemnation decisions can support unnecessary food waste.

Additional literature

Lis Alban, Elenita Ruttscheidt Albuquerque, Claudia Valeria G. Cordeiro de Sa, Patrik Buholzer, Madalena Vieira-Pinto, Nina Langkabel, Diana Meemken, Andrew Pointon, David Hamilton, Melanie Abley. 2018. Modernization of meat inspection of pigs. The world is on the move towards a more evidence-based type of inspection Fleischwirtschaft International 2: 9-15.https://www.yumpu.com/en/document/read/60181300/fleischwirtschaft-international-2-2018

WG5: Meat safety assurance system training, communication, monitoring

Main topics

- Stakeholder communication
- Evaluation of status quo of implementation of new system among EU member states
- Evaluation of training opportunities for OVs and FBOs
- Evaluation of existing EFSA documents on MSAS and their strengths, opportunities, and weaknesses
- Evaluation of training opportunities for OVs and FBOs
- Evaluation of existing EFSA documents on MSAS and their strengths, opportunities, and weaknesses

Publications and Conclusions

P1) Bojan Blagojevic, Truls Nesbakken, Ole Alvseike, Ivar Vågsholm, Dragan Antic, Sophia Johler, Kurt Houf, Diana Meemken, Ivan Nastasijevic, Madalena Vieira Pinto, Boris Antunovic, Milen Georgiev, Lis Alban. 2021. Drivers, opportunities, and challenges of the European risk-based meat safety assurance system. Food Control, 124:107870 https://doi.org/10.1016/j.foodcont.2021.107870.

> Conclusions: The modernisation process towards RB-MSAS has started and a stronger focus on targeted and risk-based inspection along the supply chain as well as use of new technologies could be a cost-effective way forward. Practical RB-MSAS implementation will be a careful process followed by thorough development and validation of feasibility and impacts. Full implementation will be dependent on intensive research to fill knowledge gaps and provide needed data to increase trust, enhanced education and training and close collaboration of all stakeholders.

P2) Boris Antunović, Bojan Blagojević, Sophia Johler, Claudia Guldimann, Madalena Vieira-Pinto, Ivar Vågsholm, Diana Meemken, Ole Alvseike, Milen Georgiev, Lis Alban. 2021. Challenges and opportunities in the implementation of new meat inspection systems in Europe. *Trends in Food Science & Technology*. 116: 460-467. DOI: 10.1016/j.tifs.2021.08.002.

> Conclusions: The new meat inspection system is only fully implemented in 61%, 42% and 38% countries in the pig, bovine, and poultry sectors, respectively. Obstacles to comprehensive implementation are existing trade agreements with third countries, the costs of implementation, missing or inadequate food chain information and meat inspectors'

resistance to change. Improvement of all components of the meat inspection systems is a prerequisite for modernisation.

P3) Silvia Bonardi, Bojan Blagojevic, Simone Belluco, Mati Roasto, Eduarda Gomes-Neves, Ivar Vågsholm. 2021. Food chain information in the European pork industry: Where are we? Trends in Food Science & Technology. 118: 833-839. https://doi.org/10.1016/j.tifs.2021.10.030

Conclusions: In the pig meat chain, HEIs cover *Salmonella* spp., *Yersinia enterocolitica, Toxoplasma gondii, Trichinella* spp., *Taenia solium* and *Mycobacteria*. Still, only two biological hazards (*Trichinella* and *Salmonella*) are currently included in official control programs in the EU countries. *Trichinella* monitoring is mandatory at EU level, and *Salmonella* control plans have been implemented by few countries. In countries where Salmonella is monitored at farm level in pigs, the status of the farm is included in the FCI. That data is important for the risk manager to implement hygienic measures and organize the slaughter operations, as well as for competent authorities to follow inspection procedures and additional controls according to Regulation No 2019/627. As FCI is intended to enable forward and backward information flow regarding animal and public health hazards between all operators in pig husbandry and meat production, the integration of HEIs will allow improved risk-based decision making.

P4) Riikka Laukkanen-Ninios, Sergio Ghidini, Jaime Gómez Laguna, Nina Langkabel, Susana Santos, Patric Maurer, Diana Meemken, Lis Alban, Ole Alvseike, Madalena Vieira-Pinto. 2022. Additional post-mortem inspection procedures and laboratory methods as supplements for visual meat inspection of finishing pigs in Europe - Use and variability. https://link.springer.com/article/10.1007/s00003-022-01391-z

Conclusions: This article shows the results of a survey performed in September 2020 on how visual meat inspection of finishing pigs is applied in Europe. By using a questionnaire, information from 44 European countries was obtained on palpations, incisions and other procedures for ten gross pathological findings and the laboratory methods applied by OVs to evaluate the fitness of meat for human consumption. Visual meat inspection (VMI) was in use as an inspection method in most countries. Export requirements were the main reason for not using VMI. The most important reasons for complementing VMI with palpations and incisions were findings detected in *ante mortem* or *post mortem* inspection. Variation was generally high in the use of palpations, incisions, other *post mortem* procedures and laboratory tests. Additional studies into these variations are necessary before harmonization of meat inspection procedures are attempted.

P5) Gunvor Elise Nagel-Alne, Emil Murphy, Brittany McCauslin, Sigrun J. Hauge, Dorte Lene Schrøder-Petersen, Janne Holthe, Ole Alvseike. 2022. Meat safety legislation and its opportunities

and hurdles for innovative approaches: A review. Food Control. 141: 109160. https://doi.org/10.1016/j.foodcont.2022.109160

> Conclusions: Red meat safety legislation texts were analyzed for normative formulations that may create non-intentional hurdles to innovation. Codex Alimentarius was determined to have less normative formulations in favor of more functional demands than the national/ regional regulations. Legislation in Europe, NZ, and the US share similarities and challenges, and all reflect prevailing processing methods. While normative legislation texts provide context that is easier to understand, they also make legislation voluminous. The findings of this review stress the mutual dependency of risk-based legislation and conditional flexibility, and between functional demands and control activities targeted on measurable objective criteria. Context or practical advice should rather come from textbooks, white papers and FBO's guidelines.

P6) Maurizio Ferri, Bojan Blagojevic, Patric Maurer, Brigita Hengl, Claudia Guldimann, Sandra Mojsova, Ioannis Sakaridis, Boris Antunovic, Eduarda Gomes-Neves, Nevijo Zdolec, Madalena Vieira-Pinto, Sophia Johler. 2023. Risk-based meat safety assurance system - An introduction to key concepts for future training of official veterinarians. Food Control. 146: 109552. https://doi.org/10.1016/j.foodcont.2022.109552

> Conclusions: RB-MSAS implementation and fine-tuning requires the overcoming of gaps pertaining to research, roles, responsibilities, positioning, and training of the OV as risk manager, along with increased FBO awareness of their own roles and responsibilities. The main prerogatives of RB-MSAS revolve around rapid exchange of information back and forth throughout the farm-to-fork continuum. HEIs and minimum monitoring and inspection requirements are crucial in this context. The implementation of RB-MSAS also relies on trust and coordination between operators and decision makers, collaboration of stakeholders, risk analysis training, rapid and effective diagnostic aids, as well as the implementation of novel and cost-effective tools. OVs need a high level of competence that will be reached with education and practical training in epidemiology, risk assessment, and the use of FCI/HEIs and new technologies. RB-MSAS can reduce the costs of treating diseases, lower production losses, and enhance retailers' and consumers' trust. There is substantial global buy-in to risk-based frameworks, and a clear value for the OV as a risk manager to assess and control hazards to improve public health.

P7) Eduarda Gomes-Neves, Margarida F. Cardoso, Thomai Lazou, Brigita Hengl, Silvia Bonardi, Bojan Blagojevic, Claudia Guldimann, Sophia Johler. 2023. Official veterinarians in Europe: questionnaire-based insights into demographics, work and training. Food Control. 153:109947. https://doi.org/10.1016/j.foodcont.2023.109947

Conclusions: The study showed that OVs are a highly qualified professional group, with country and age related differences in previous training and experience requirements to enter the OV career. The average age of the OVs was rather high, which should be a matter of concern for competent authorities. The novel legislation positioning OVs as risk managers necessitates to reinforce OVs with new training elements to allow them to fulfill their highly diverse duties. Regarding the modernisation of meat inspection and RB-MSAS, OVs do not feel completely confident that they are able to support risk-based meat inspection due to a lack of available resources. This matter needs to be addressed by competent authorities. Topics suggested for future training were risk-based meat inspection, meat safety assurance systems and relevant components (food chain information, harmonized epidemiological indicators etc.), as well as chemical hazards. Stronger involvement of universities/academia in continuing education could be beneficial and an online platform for sharing of experiences and training materials was suggested.