



RIBMINS

2nd RIBMINS Scientific Conference

**"Towards the Future of Meat Safety
Assurance"**

7-8 April 2022 – Córdoba + online

Book of Abstracts

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Proceedings of the 2nd RIBMINS Scientific Conference, 7-8 April 2022, Córdoba + online

Editors: Boris Antunovic, Elena Carrasco Jiménez, Claudia Guldemann, Sophia Johler, Brigitte Sperner & Bojan Blagojevic

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Conference programme

Thursday, 7th April

9.00 – 9.10	Jose Carlos Gómez Villamandos (Rector of the University of Cordoba) Jose María Bellido Roche (Major of Cordoba)	Opening conference
9.10 – 9.15	Elena Carrasco	Housekeeping issues
9.15 – 9.30	Bojan Blagojevic	RIBMINS update
Moderator: Bojan Blagojevic		
9.30 – 10.10	Keynote lecture – Rens van Dobbenburgh	The role of the veterinarian in improving the integrity of the food chain
Moderator: Lis Alban		
10.10 – 10.50	Keynote lecture – Arja Kautto	Digital transformation in meat inspection at slaughter and game handling – Opportunities for the future
<i>10.50 – 11.20</i>	<i>Break (coffee and poster* viewing for live participants)</i>	
Moderator: Ivar Vågsholm		
11.20 – 12.20	WG1 session: Scope and targets of meat safety assurance	
11.20 – 11.30	Ivar Vågsholm	WG1 update
11.30 – 11.40	Lis Alban	Mapping of detection and management of residues of antimicrobials in pigs delivered to an abattoir
11.40 – 12.00	Mati Roasto (online)	<i>Salmonella enterica</i> in the Estonian meat production chain
12.00 – 12.20	Simone Belluco	Critical elements of meat safety assurance efficacy
Moderator: Claudia Guldemann		
12.20 – 13.20	WG5 session: Meat safety assurance system training, communication and monitoring	
12.20 – 12.30	Sophia Johler	WG5 update
12.30 – 12.55	Eduarda Gomes-Neves	A survey for the assessment of demographics and training needs of official veterinarians in Europe
12.55 – 13.20	Janne Holthe	Different interpretations of legislation in European countries
<i>13.30 – 14.30</i>	<i>Lunch break (poster* viewing for live participants)</i>	
14.30 – 17.00	Separate WG meetings	

*for online participants posters will be posted on RIBMINS webpage

Friday, 8th April

Moderator: Madalena Vieira-Pinto

9.00 – 9.40 **Keynote lecture – Steve Hathaway (online)** **Risk-based assurance systems for fresh meat: A work in progress**

Moderator: Truls Nesbakken

9.40 – 10.40 **WG2 session: Farm level controls and risk categorisation of farms**

9.40 – 9.50 Diana Meemken WG2 update

9.50 – 10.10 Ting-Ting Li Food Chain Information: Results from a Europe-wide online-survey on the status quo and improvements for broilers, pigs, and bovines

10.10 – 10.40 Maria Rodrigues da Costa Using systematic reviews to assess the effectiveness of pre-harvest meat safety interventions to control foodborne pathogens in broilers, pigs and bovines

10.40 – 11.10 Break (coffee and poster viewing for live participants)*

Moderator: Dragan Antic

11.10 – 12.10 **WG3 session: Abattoir level controls and risk categorisation of abattoirs**

11.10 – 11.20 Dragan Antic WG3 update

11.20 – 11.45 Morgane Salines Pig abattoir interventions in a risk-based meat safety assurance system: A systematic review and meta-analysis of the efficacy of interventions to reduce microbiological contamination on pig carcasses

11.45 – 12.10 Nikolaos Dadios Beef abattoir interventions in a risk-based meat safety assurance system: A systematic review and meta-analysis of the efficacy of interventions to reduce microbiological contamination of beef carcasses with *Escherichia coli*

Moderator: Jaime Gomez Laguna

12.10 – 13.10 **WG4 session: Impact of changes and alternatives to traditional meat inspection**

12.10 – 12.30 Ole Alvseike (online) WG4 update

12.30 – 12.50 Marianne Sandberg VetInspector – a computer vision system for post mortem inspection of chicken

12.50 – 13.10 Madalena Vieira-Pinto & Riikka Laukkanen-Ninios A European survey on post-mortem inspection of finishing pigs

13.10 – 13.15 Closing conference

13.15 – 14.00 Lunch break (poster viewing for live participants)*

14.00 – 16.00 **MC meeting (restricted to MC members and other invited delegates)**

*for online participants posters will be posted on RIBMINS webpage

Scientific Committee

Bojan Blagojevic (Serbia)
Lis Alban (Denmark)
Ivar Vågsholm (Sweden)
Simone Belluco (Italy)
Diana Meemken (Germany)
Truls Nesbakken (Norway)
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About RIBMINS

RIBMINS (Risk-based meat inspection and integrated meat safety assurance) is a COST Action funded by the European Commission covering different activities in the period 2019-2023. The main aim of the RIBMINS network is to combine and strengthen European-wide research efforts on modern meat safety control systems. The network allows exchange of ideas, experience and results of country-level research studies. Other important aims are to create a platform for training relevant participants in the new meat safety assurance systems and thus help the operability, as well as to inform relevant stakeholders about the requirements, benefits and consequences of the new systems. Within RIBMINS, short-term scientific missions, training schools, workshops and conferences are organised. Overall, the network aims to help the full development and implementation of the general principles of meat safety assurance systems across Europe for the benefit of consumers and industry and protection of animal health and welfare.

The RIBMINS network scope of work, ongoing activities and news can be regularly followed at www.ribmins.com, as well as through social media ([Twitter](#), [LinkedIn](#), [ResearchGate](#)).



Participants of RIBMINS workshops and working group meetings held at the University of Copenhagen, Denmark (7th - 8th November 2019)

ABSTRACTS OF KEY-NOTE LECTURES

The role of the veterinarian in improving the integrity of the food chain

Francesco Proscia¹, Rens Van Dobbenburgh², Nancy De Briyne³

¹Senior policy officer, Federation of Veterinarians of Europe (FVE)

²President, Federation of Veterinarians of Europe (FVE)

³Executive Director, Federation of Veterinarians of Europe (FVE)

The Federation of Veterinarians of Europe (FVE) represents around 300,000 veterinarians across the European region and is an official stakeholder to the EU Institutions. FVE aims to promote One Health through enhancing animal health, animal welfare, public health and the health of ecosystems. Veterinarians play a key role in One Health as they prevent, monitor and control the spread of animal diseases, use medicines responsibly, ensure food safety and security, and prevent environmental contamination and other health threats shared by people, animals and the environment. Along the food chain, veterinarians make sure that food of animal origin is safe, from farm to fork. This is especially the case where livestock are processed at the slaughterhouse and meat safety is a key component of the overall surveillance system for animal health and welfare. FVE recognises that the risks in meat hygiene and the capacity to prevent them have changed gradually over time, as well as that the different socio-economic situations, establishment types and activities, and different animal and public health risks exist across the Member States¹. Since the very first meeting on the modernisation of meat inspection, FVE has been involved in the development and approach to risk-based meat safety assurance. FVE strongly calls for the full engagement of all veterinarians with the modernisation process to lead the change in the directions of public good and increased efficient controls and, in turn, towards more sustainable livestock production and management. Technology and innovation and the scientific evidence provided so far by the European Food Safety Agency (EFSA) and further EU projects place the veterinary profession at the core of the risk-based meat safety assurance systems so that the consumers and farmers can be best served by modern and efficient food safety systems. FVE believes also that the meat safety assurance system can be best achieved through proper checks on the farm² so that potential hazards can be discovered early and, therefore, reduced. Integrated herd/flock health planning and a system of veterinary-led checks are enhanced by robust Food Chain Information and timely communication of audit-inspection results to the farmer ([FVE FCI guidance](#)). FVE points to the need to further invest in meat safety and the food systems in general, as they are the backbone of improved global health, sustainability³ and security.

¹FVE position paper - [Vets adding value](#)

²FVE position paper - [Animal health visits](#)

³[Veterinarians commit to sustainable food systems](#)

Digital transformation in meat inspection at slaughter and game handling – Opportunities for the future

Arja Helena Kautto¹

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Since 2018, the Swedish Food Agency (SFA) has focused on creating prerequisites to achieve our future vision – that digital transformation takes its rightful place in meat control. The objectives are to develop and implement: (i) remote control devices for ante mortem (AMI) and post mortem inspections (PMI) in small abattoirs and game handling establishments (GHE) in geographically constrained areas; and (ii) supporting artificial intelligence (AI) equipment at larger abattoirs with high speed slaughter lines. The Swedish government supports this development strategy through earmarked resources. During 2019, two pilot studies were supposed to start regarding AI for meat inspection at abattoirs and augmented reality (AR) assisted meat inspection. However, due to the Covid-19 pandemic, the AI study was cancelled. The AR was studied at a larger pig abattoir in Sweden (about 700,000 pigs /year) in order to assess the reliability and feasibility of using a smart phone for remote PMI. Food safety, animals and animal welfare were not compromised. Sweden is geographically a long country and the number of small abattoirs and GHE (<1,000 tons/year) is high in relation to their production volume. Moreover, these establishments have increased by 30 % since 2008. The time used for travelling back and forth by official control staff to these remote sites has increased by 80 % since then. During 2017, travel costs were about 18 million SEK (8 % of the total cost of all controls). These small establishments constitute 83 % (170 of 204 establishments, 2020) of all abattoirs, while their throughput is only about 12 % of the number of slaughtered animals in Sweden. The drivers for the SFA to develop the meat control are: (i) to reduce official meat control's environmental burden and better align controls with the sustainability goals in Sweden; (ii) constraints on production and profits in small abattoirs and GHE due to the logistic hurdles, such as travel for official veterinarians between establishments; (iii) a desire for more resilience in the food chain; and (iv) difficulties in AMI and PMI calibration. Hence, regarding this last point, digital systems should be used to keep up the impartiality, quality and consistency of official controls. SFA is continuing this work with a view to present a feasible model for remote meat control in 2023.

Risk-based assurance systems for fresh meat: A work in progress

Steve Hathaway¹

¹Adjunct Professor of Food Safety, Massey University, New Zealand

Food safety assurance systems that are risk-based are now the declared goal of most modern legislative frameworks, although the design, validation and implementation of such systems for fresh meat remain somewhat elusive. Decisions on control measures throughout the food chain require multi-criteria inputs, and the transparent provision of risk-based elements presents considerable challenges. This paper will explore the considerable advances in meat hygiene that have been achieved over the last two decades, as well as illustrating the continuing necessity for practical trade-offs between risk-based and hazard-based approaches in the design of assurance systems.

ABSTRACTS OF ORAL PRESENTATIONS

Mapping of detection and management of antimicrobial residues in pigs delivered to an abattoir

Lis Alban^{1,2} – on behalf of WG1 working group on antimicrobial residues³

¹Danish Agriculture & Food Council, Copenhagen, Denmark

²University of Copenhagen, Frederiksberg, Denmark

Consumers do not like the idea that there might be residues in the food they consume. Therefore, activities are in place related to the detection and management of residues of licensed antimicrobial substances. One question is what a best set of practices in this regard could be, considering that the prevalence is low, and unnecessary condemnations will have a negative impact on the general environmental footprint associated with the sector. To address these issues, a survey is currently being undertaken, targeting activities related to pigs delivered to an abattoir. This includes the routine monitoring developed and implemented by the competent authorities (CA) and the food business operators (FBO). Moreover, focus is on the management of a case, where a pig producer has provided food chain information (FCI) indicating compliance regarding withdrawal periods, but later discovers that a pig was delivered - and maybe slaughtered - before the end of this period. During the development of the questionnaire, input was received from CA and FBO, in- and outside Europe. The target audience is the staff of the CA and the FBO. The questionnaire does not cover monitoring of illegal veterinary substances or environmental pollutants. Nor is monitoring of live animals on the farms covered.

Links to the electronic survey can be found on the RIBMINS website, where there is one link targeting the CA and another the FBO. The survey is open until the end of May 2022.

The results will include a discussion of the similarities and variations between countries, identification of different sets of countries' best practices, and more precise objectives for monitoring and control of residues. The outcome may act as a basis for improved and cost-effective routine monitoring supported by evidence-based procedures regarding condemnation of carcasses and by-products that could potentially contain antimicrobial substances. This could in the long run also lead to a more harmonised approach and reduced food losses without jeopardizing consumer safety. Hence, improved food security and reduced resource footprints of pork production are anticipated, in line with the EU ambition to ensure a more climate friendly and sustainable future.

³Additional members of the project group: Ian Jensen (AU), Jesper Valentin Petersen (DK), Fernando Perez Rodriguez & Rosa M^a Garcia-Gimeno (ES), Ioannis Sakaridis (GR), Boris Antunovic (HR), Silvia Bonardi (IT), Aivars Bērziņš¹ (LV), Derk Oorburg (NL), Madalena Vieira Pinto (PT), Madalina Belous & Alexandrina Sirbu (RO), Ivar Vågsholm & Arja Helena Kautto (SE)

***Salmonella enterica* in the Estonian meat production chain**

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Salmonella enterica is an important public health concern in Estonia and worldwide, and farm animals are known as an important reservoir of these bacteria.

In the present study, samples at different stages of the meat production chain in Estonia were collected during the five-year period of 2016–2020. At farm level, 119 fattening pig herds, 583 cattle herds and 3183 broiler chicken flocks were studied to determine the *Salmonella* prevalence and related serotypes. Sampling was also performed at slaughterhouse and meat cutting levels, where a total of 3060 and 1926 samples were collected, respectively. At farm level, faecal samples were taken. At slaughterhouses, abrasive sponges were used to sample carcass surfaces. For poultry at slaughterhouse level, neck skin samples were taken. At the meat cutting level, the fresh meat from a processing line was sampled. All samples, collected from different levels of the meat chain, were analysed in the Veterinary and Food Laboratory of Estonia. *Salmonella* was isolated and identified as described in the standard method ISO 6579. Identification to serotype level was performed by the Kauffmann-White-Le Minor scheme using commercially available antisera. Additionally, human salmonellosis data over the same period was analysed to determine the serotypes that caused human *Salmonella* infections. The *Salmonella* prevalence was very high (27.7%, 95% CI 20.1–36.8) in fattening pigs at farm level, but it was much lower in cattle farms (3.3%, 95% CI 2.0–5.1) and in poultry flocks (0.1%, 95% CI 0.02–0.3). The most prevalent serotype at farm level for fattening pigs was *S. Derby*. For cattle, the most prevalent serotypes were *S. Typhimurium* including the monophasic variant, and *S. Dublin*. Including pigs, cattle and poultry, the most prevalent serotypes at slaughterhouse and meat cutting levels were *S. Derby*, monophasic *S. Typhimurium* and *S. Typhimurium*, with proportions of 64.7%, 9.4% and 7.0%, respectively. Also, we found these serotypes to be among the five most common serotypes responsible for human *Salmonella* infections in Estonia. Almost 50% of human *Salmonella* infections in Estonia are caused by *S. Enteritidis*. However, this serotype has not been found at the slaughterhouse or at the meat cutting level in Estonia. This study revealed that in recent years, monophasic *Salmonella Typhimurium* has become more epidemiologically important in Estonia. Monophasic *S. Typhimurium* is the second biggest cause of human infections and the third most prevalent serotype in the Estonian meat chain. Regarding the Estonian meat chain, the epidemiologically important *Salmonella enterica* serotypes were found to be the monophasic *S. Typhimurium*, *S. Typhimurium* and *S. Derby*. Due to the high prevalence of *Salmonella*, more attention needs to be paid to this pathogen at fattening pig farm level in Estonia.

Critical elements of MSAS' efficacy

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Meat safety assurance systems (MSASs) comprise the whole set of measures aimed at guaranteeing the delivery of safe food for human consumption.

The effectiveness of such systems depends mostly upon two key elements: policy (both public and private) and compliance. Each of them is a necessary but not sufficient condition to reach the goal.

Over the years, major changes have occurred to the regulation of safety in the meat chain. The major driver of change has been the need to ensure consumer protection with a lower regulatory cost for the public. This has led to the development of private standards. The roadmap to achieve safe food is composed of different strategies based on governance, regulations, and private standards – all based upon science.

Pillars of this change are the shift from a specification-based to a performance-based approach and the need for evidence-based policy to support this change.

To reach the goal, active involvement of the Food Business Operators is needed. Moreover, compliance is needed by all parties and can be guaranteed by different public and private enforcement strategies based on incentives or sanctions. Besides public enforcement, other elements can be useful, such as: the market's self-regulation based on structural (vertical integration) or functional reduction of information asymmetry resulting from the increased use of private standards, and the growing understanding of the importance of food safety culture for the conscious implementation of the policy.

In this landscape, evaluating the effectiveness of a MSAS is all but an easy task. One strategy could be to evaluate it as a whole relying on epidemiological indicators such as Disability Adjusted Life Years (DALY) or number of cases and comparing them with the chosen Appropriate Level of Protection (ALOP). This possibility is often impaired by the lack of reliable data. In addition, it is unable to give information about the major drivers and barriers of effectiveness. Post-mortem meat inspection is a good example in this context, as ALOP for various parasitic diseases was met, not because of the effectiveness of the policy-compliance combination but because the risks were no longer relevant.

A survey for the assessment of demographics and training needs of official veterinarians in Europe

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Veterinarians are experts in animal health and welfare and public health, playing an essential role in controlling and defending the safety and quality of food of animal origin. Official veterinarians (OVs) are a vital part of food safety assurance as they perform the official controls for the national authorities. The way official controls will be carried out in Europe in the future is currently under revision. The ongoing implementation of modernised meat safety assurance systems, from traditional inspection to risk-based meat safety assurance, requires OVs to adapt their control processes. They need to act as risk managers who consider harmonised epidemiological indicators and food chain information. However, to date, the demography, training opportunities and training needs of OVs remain to be assessed and likely vary widely across Europe. An online anonymous questionnaire was developed, tested in a pilot study and approved by the Ethics Committee of the University of Porto, Portugal. The objective of this survey tool, encompassing eight groups of questions, was to characterise OVs in terms of demography and employment, and to identify continuous education and training needs. To reach as many OVs working in Europe as possible, the questionnaire was translated into 17 different languages and was available to recipients from 1st December 2021 to 31st March 2022. This survey tool was disseminated through RIBMINS national contact points, the Federation of Veterinarians of Europe, the European College of Veterinary Public Health as well as professional and personal networks in the countries participating in the RIBMINS project. Over 1,700 OVs from 30 countries have completed the questionnaire. The data obtained will enable the characterisation of this professional group and help to identify training needs and develop effective future training tools.

Different interpretations of legislation in European countries

Janne Holthe¹, Sigrun J. Hauge¹, Ole Alvseike¹

¹Animalia – Norwegian Meat and Poultry Research Centre

The Norwegian Food Safety Authority (CA) demanded in 2012 and again in 2015 and 2018 that seven Norwegian abattoirs, using a method (“cutting”) that included transection of the rectum for evisceration of sheep carcasses, change their method of evisceration to one that does not include cutting through the intestines. The CA claims that the legislation (Regulation (EC) No. 853/2004) does not allow for the cutting of the rectum, and that it is not possible to use the method without contaminating the carcass. In these slaughter lines, the rectum is stretched, streaked and then transected. The rectal part automatically contracts into the pelvic cavity. Finally, the rectum is loosened with a circumanal incision and pulled out aborally. With the alternative method (“bagging/bunging”) the rectum is loosened, sealed with a plastic bag, pushed through the pelvic cavity, and taken out with the abdominal viscera. “Cutting” is a common method used in European abattoirs.

Consequently, a study was launched to compare the hygienic quality in the pelvic area of sheep carcasses eviscerated with the two methods. In the study by¹, the 18 largest sheep abattoirs (98 % of volume) in Norway participated. There were two sample areas a) 400 cm² inside the pelvic cavity (n=623) and b) 100 cm² outside the circumanal incision (n=622). Swabbing was undertaken on cold carcasses 24 hours post mortem. The samples were pooled by swabbing the same area of five carcasses, making the total number of swabbed carcasses 3115. Abattoirs’ quality managers performed standardised sampling². The samples were analysed for *E. coli*. Mean *E. coli* from the method “bagging” was -1.61 log CFU/cm² inside the pelvic area and -0.25 log CFU/cm² outside, while mean *E. coli* from the method “cutting” was -1.56 log CFU/cm² inside and -0.42 log CFU/cm² outside. The *E. coli* results from samples taken inside the pelvic cavity were significantly lower than those taken from the outside, irrespective of the method of evisceration. However, we were not able to detect a significant difference between the methods of evisceration, either inside or outside the pelvic cavity. Microbiologically acceptable results were achieved with both methods. There are challenges with both methods and both require skilled and experienced operators to minimise the contamination. Although this large study shows that there is no significant difference in terms of hygienic quality in the pelvic area of sheep carcasses, the CA still claims to this day that the method of “cutting” cannot be used as a method of evisceration in Norway. The case exemplifies the importance of common understanding and calibrated interpretation of legislation. For example, UECBV accepts the “cutting” method in their drafted EU community guideline *Sharing Good Practice in Slaughter Hygiene*³. The Norwegian meat industry perceives the CA’s interpretation as a prescriptive demand, i.e., “how a method should be”, without reference to objective criteria or sound documentation. It underlines the benefit of functional demands in legislation, i.e., “what should objectively and measurably be achieved (aim)”.

1. Røssvoll, E et al. A comparison of two evisceration methods on hygienic quality in the pelvic area of sheep carcasses. *Meat Sci.* 137, 134–138 (2018).

2. Hauge, S.J and Alvseike, O. Prøvetaking av lam. YouTube. www.youtube.com/watch?v=V3o8Cqh3WDQ (2014).

3. Anon. SHARING GOOD PRACTICES IN - Ovine Animals. 1–17 (2017).

Food Chain Information: Results of a Europe-wide online-survey on the status quo and improvements for broilers, pigs, and bovines

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With the help of Food Chain Information (FCI) according to Regulation (EC) No 853/2004, risk categorization and analysis of farms can be conducted as part of the risk-based meat inspection to protect human health. The EU regulation, however, does not specify in detail which data should be collected. As a result, there are country-specific/abattoir-specific implementations. It therefore appears that the information content throughout Europe is heterogeneous. To evaluate the current situation of FCI, an online survey was conducted as part of the COST Action (CA18105) project RIBMINS (Risk-based meat inspection and integrated meat safety assurance) by members of Working Group 2. Questionnaires were disseminated among the 33 participating countries to determine the status quo and potential improvements on FCI for broilers, pigs, and bovines (Nov.-Dec. 2020). In total, 32 participants from 14 different countries responded to the broiler-questionnaire, 51 participants from 17 countries to the pig-questionnaire, and 58 participants from 18 countries to that for bovines. The results regarding the information content of the FCI showed clear differences between the three species, particularly with regard to herd health. Only about 50.0% of the respondents, both for pigs and bovines, indicated that they would have access to data regarding treatments with a withdrawal period > 0 days. This means, more than half of the respondents said that they would not receive these treatment data, which are mandatory by EU regulation. For broilers, at least 84.4% received this information. Data from previous *ante-mortem* (a.m.) and *post-mortem* (p.m.) inspections of animals from the same producer is also an obligatory part of FCI. Overall, only 64.5% of respondents had access to a.m. data and 69.5% to p.m. data. 57.4% of all respondents assessed FCI as helpful for decision-making regarding food safety. The majority of respondents that assessed FCI as helpful worked in the broiler sector (75.0%), followed by the pig sector (56.9%), and the bovine sector (48.2%). Accordingly, almost half of the participants appear dissatisfied with the FCI currently available. The proposed improvements to the FCI show species-overlapping agreements for indicators on mortality, treatment data, data from the private veterinarian, and clean livestock policy. Additionally, some proposals were species-specific, like pregnancy data for bovines and multi-serological results for pigs. In conclusion, FCI is lacking important information on herd health for an adequate risk categorization and therefore needs improvement and standardization. It should be specified with more detailed information as well as predefined consequences.

Using systematic reviews to assess the effectiveness of pre-harvest meat safety interventions to control foodborne pathogens in broilers, pigs and bovines

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Stakeholder cooperation along the food chain is the central element of the risk-based approach to meat hygiene. Since meat hygiene already starts with animal husbandry, the aim of this project is to assess pre-harvest meat safety interventions by means of systematic literature reviews for the animal species broilers, pigs and bovines. The inclusion and exclusion criteria for the systematic literature reviews were the same for all three animal species with the exception of the chosen time limit: broilers: 2015–2020, pigs and bovines: no time limit. EFSA Scientific Opinions on the public health hazards related to meat from swine, poultry and bovine animals (2011, 2012, and 2013, respectively) were the basis for the selection of pathogens that were included. Fifty-one studies regarding *Campylobacter* spp., *Salmonella*, VTEC, ESBL-AmpC *Escherichia coli*, and *Clostridium perfringens* were included in the broiler review. Research mostly focused on *Salmonella* and *Campylobacter* spp., with biosecurity and management interventions having mixed outcomes. The effectiveness of feed additives remains controversial. Overall, studies on recent developments of novel pathogen-specific immunisation strategies are lacking. In pigs, fifty-one studies were retained contemplating five pathogens. *Salmonella* was the most investigated (n=42 studies) with feed and/or water treatments and vaccination being the most researched interventions and having positive results. Overall, high health status coupled with good management and biosecurity are effective to control most foodborne pathogens in pork. Both in broilers and pigs, research on many pathogens was scarce or with focus on epidemiology/source-attribution studies. This may be partly explained because these pathogens are frequently controlled by post-harvest interventions. For bovines, a total of 1514 studies were retrieved for 13 pathogens. After the abstract and full-text screenings, a total of 35 studies for six pathogens remained. These were: *Salmonella* (n=16 studies), VTEC (n = 13 studies), *C. botulinum* and *C. perfringens* (n=2 studies), and *Campylobacter*, and ESBL_AmpC (n=1 study each). Data extraction and interpretation is still ongoing. This systematic review is expected to be submitted for peer-review in June 2022.

Pig abattoir interventions in a risk-based meat safety assurance system: A systematic review and meta-analysis of the efficacy of interventions to reduce microbiological contamination on pig carcasses

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Interventions from the lairage to the chilling stage of the pig slaughter and dressing process are important to reduce microbial contamination of carcasses and, therefore, constitute an essential part of meat safety assurance systems. A systematic review and meta-analysis of literature investigating the efficacy of interventions during primary processing to control microbiological contamination on pig carcasses was performed. The main objective was to assess the effectiveness of abattoir interventions in reducing aerobic colony count (ACC), *Enterobacteriaceae*, generic *Escherichia coli* and *Yersinia* spp. on pig carcasses. Following a structured systematic review process, a total of 22 studies, which were judged as of low risk of bias, were used for detailed data extraction and meta-analysis. Of these, there were 16 studies conducted in commercial abattoirs, two in research plants and five studies conducted under laboratory conditions. Regarding study design, eight papers reported controlled trials, five reported challenge trials and twelve papers reported use of before-and-after study design. Lairage interventions for live pigs were investigated in only two studies, pre-chill carcass interventions were investigated in 17 studies, carcass chilling in eight and multiple interventions in five studies. The summary effects from a random-effect meta-analysis model were generated. Several commercial trials found that pig carcass scalding was effective in reducing the prevalence of *Enterobacteriaceae* (RR 0.05) and ACC (2.84 log₁₀ CFU/cm²). Similarly, a significant reduction of these two groups of indicator bacteria on carcasses was found after singeing (RR 0.25, and 1.95 log₁₀ CFU/cm², respectively). Rectum tying was effective in reducing the prevalence of *Y. enterocolitica* on pig carcasses (RR 0.60). A multiple hurdle approach that included a sequential application of carcass interventions significantly reduced *Enterobacteriaceae* prevalence (RR 0.11) and ACC on carcasses (2.85 log₁₀ CFU/cm²). Overall, the results suggest that scalding, singeing, washing with hot water and lactic acid, and dry chilling are effective in reducing indicator bacteria on pig carcasses. The meta-analysis also found evidence that pathogenic *Y. enterocolitica* on pig carcasses is effectively reduced by the standard procedure of tying the rectum; however, this was the only intervention for *Yersinia* investigated under commercial conditions.

Beef abattoir interventions in a risk-based meat safety assurance system: A systematic review and meta-analysis of the efficacy of interventions to reduce microbiological contamination of beef carcasses with *Escherichia coli*

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The interventions at abattoir level are considered necessary to control microbiological hazards and, therefore, constitute an essential and integral part of meat safety assurance systems. A systematic review and meta-analysis of literature investigating the efficacy of interventions during primary processing to control microbiological contamination in beef was performed. A systematic review identified 266 relevant studies, with 113 (42.5%) judged to be at 'low' risk of bias, including 58 on beef carcass interventions' effects on generic *E. coli* and pathogenic *E. coli* where extractable data were available for meta-analysis. Of these, there were 27 studies conducted in commercial abattoirs, 11 in research plants and 21 studies conducted under laboratory conditions. Regarding study design, only three controlled trials were identified, 32 papers reported studies utilising challenge trials and 27 using before-and-after design. Pre-chill carcass interventions were investigated in 39 studies, carcass chilling in 19 and multiple interventions in five studies. The summary effects from a random-effect meta-analysis model were generated. Several commercial trials found that final beef carcass wash using cold or warm water largely showed no evidence of a reduction of prevalence of *E. coli* on carcasses before chilling (RR 0.88). Steam and hot water carcass pasteurisation had the largest potential impact on decreasing the prevalence and concentration of *E. coli* on contaminated beef carcasses. Hot water wash led to a significant reduction in generic *E. coli* counts on beef carcasses, 0.59 log₁₀ CFU/cm², and significantly reduced the prevalence of generic *E. coli* (RR 0.32) in trials performed under commercial abattoir conditions. Similarly, studies performed under commercial abattoir conditions found that steam pasteurisation significantly reduced generic *E. coli* prevalence on beef carcass sides (RR 0.15). Lactic acid pre-chill wash showed no evidence of a reduction in generic *E. coli* prevalence (RR 0.93) and counts (0.63 log₁₀ CFU/cm²) on beef carcasses. When hot water or steam pasteurisation treatments were applied to carcasses prior to lactic acid spray wash, there was a significant reduction of *E. coli* prevalence on beef carcass sides (RR 0.01). Dry chilling following multiple interventions under abattoir conditions led to a significant reduction of *E. coli* prevalence (RR 0.07) and counts (0.60 log₁₀ CFU/cm²) on beef carcass sides. Overall, carcass pasteurisation treatments and lactic acid wash can be recommended for use in beef abattoirs.

VetInspector – a computer vision system for post mortem inspection of chicken

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Ante mortem and post mortem inspection (PMI) including inspection of hygiene, are activities in a meat safety assurance system as described in the new meat inspection legislation of the EU. The existing PMI of chickens is manually conducted by the official veterinarians (OVs) – sometimes above a slaughter speed of 12,000 chickens per hour. Even higher slaughter speeds might imply that the manually conducted PMI will be utterly challenged, resulting in a further rise in the intra- and inter-rater variation. VetInspector is a computer vision system based on image-analysis that can be used to support PMI of chicken. In the development process of VetInspector, feasibility, agreement and performance studies were conducted. These studies revealed that VetInspector is feasible for PMI of chicken. Moreover, there was shown about 30 % disagreement between the veterinarians, when grading/rating pictures of carcasses/viscera with different lesions. The performance study revealed that among the carcasses and viscera that the OVs had approved, the veterinary graders/raters assessed that 1 % of them had lesions and should not have been approved. Similarly, 2 % of the viscera approved by the OVs should not have been approved. Hence, despite uncertainty related to the exact figures of performance, clearly, some chicken carcasses were “wrongly-classified” in the manually-conducted PMI. Cut-offs between approved/not approved for carcasses with different lesions/severity of lesions should be based upon the most updated scientific evidence and based on microbiological assessment of carcasses with and without lesions. Implementation of VetInspector will improve feedback to the farmers on chicken flock health status.

A European survey on post-mortem inspection of finishing pigs

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An online survey was prepared by WG4 of the COST Action 18105 - RIBMINS (www.ribmins.com) to address the degree of variation on ways of post-mortem inspection (PMI) of finishing pigs in Europe, based on Commission Implementing Regulation (EU) 2019/627. The specific objectives included the mapping of: Post-mortem condemnation criteria to decide if meat is fit for human consumption; Additional procedures in place on top of visual inspection for assessing whether meat is fit for human consumption; Detection ability of visual-only PMI for different gross pathological findings; Databases in place to record total and partial condemnations and terminology used (codes). After validation, the questionnaire was sent to official veterinarians via the RIBMINS national contact points. From September to November 2020, 44 responses were obtained from 26 European countries. The results showed ample variations between respondents, reflecting different experiences and practices regarding PMI code systems, judgement criteria and associated procedures regarding condemnations. This variation may undermine the importance that PMI data should have in animal health monitoring, feedback to livestock producers and veterinarians, and for calibration and benchmarking. Through this information we expect to share knowledge and experiences, involving evidence and people, that can be used to elucidate the different approaches regarding PMI of finishing pigs. This may be used as an inspiration towards a possible harmonisation, aiming at minimising food waste, improving decision-making and comparative analysis between different reports.

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ABSTRACTS OF POSTER PRESENTATIONS

The impact of slaughter processing on *Escherichia coli* and cephalosporin-resistant *Escherichia coli* counts on broiler chicken carcasses

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Antimicrobial resistance (AMR) is a global threat to public health and tackling AMR is a high priority area for both researchers and food safety competent authorities. Chicken meat is a common source of *Escherichia coli* and cephalosporin-resistant *E. coli*. This study aimed to investigate *E. coli* and cephalosporin-resistant *E. coli* contamination of chicken carcasses at four different steps of abattoir processing (post-defeathering, post-evisceration, post-ultrasound intervention and post-chilling) to quantify the effect these processing steps on carcass contamination. In total, 230 chicken neck skin samples from six batches (six processing days) were collected at random along the slaughter line (10 per processing step, post-intervention samples were not taken on one day due to technical difficulties). Microbiological analysis was performed according to the EU Reference Laboratory guidelines (Quantification of ESBL/AmpC-producing *Escherichia coli* in caecal content and fresh meat samples, 2017). Both *E. coli* and cephalosporin-resistant *E. coli* counts decreased significantly along the slaughter processing between the post-defeathering and post-chilling steps. Overall, *E. coli* levels decreased from $4.11 \pm 0.67 \log_{10}$ CFU/gr to $3.04 \pm 0.60 \log_{10}$ CFU/gr of neck skin (significant reduction of $1.07 \log_{10}$, $p < 0.001$). Cephalosporin-resistant *E. coli* levels decreased from $2.36 \pm 0.29 \log_{10}$ CFU/gr to $0.24 \pm 0.80 \log_{10}$ CFU/gr of neck skin (significant reduction of $2.12 \log_{10}$, $p < 0.001$). The highest individual reduction effect in *E. coli* counts was observed post-ultrasound intervention, from $4.32 \pm 0.75 \log_{10}$ CFU/gr to $3.60 \pm 0.63 \log_{10}$ CFU/gr of neck skin (reduction of $0.72 \log_{10}$, $p < 0.001$). Similarly, ultrasound intervention significantly reduced counts of cephalosporin-resistant *E. coli*, from $2.44 \pm 0.32 \log_{10}$ CFU/gr to $1.63 \pm 0.84 \log_{10}$ CFU/gr of neck skin (reduction of $0.81 \log_{10}$, $p < 0.01$). Chilling was found to have slightly lower, but still significant reduction effect on *E. coli*, from $3.60 \pm 0.63 \log_{10}$ CFU/gr to $3.04 \pm 0.60 \log_{10}$ CFU/gr of neck skin (reduction of $0.56 \log_{10}$, $p < 0.001$). On the other hand, cephalosporin-resistant *E. coli* were greatly reduced, from $1.63 \pm 0.84 \log_{10}$ CFU/gr to $0.24 \pm 0.80 \log_{10}$ CFU/gr of neck skin (reduction of $1.39 \log_{10}$, $p < 0.001$). Evisceration increased carcass contamination slightly, but not significantly. *E. coli* and cephalosporin-resistant *E. coli* counts increased during evisceration from $4.11 \pm 0.67 \log_{10}$ CFU/gr to $4.33 \pm 0.75 \log_{10}$ CFU/gr, and from $2.36 \pm 0.29 \log_{10}$ CFU/gr to $2.44 \pm 0.32 \log_{10}$ CFU/gr of neck skin, respectively (both $p > 0.05$). In conclusion, this study found that the ultrasound intervention is effective in reducing *E. coli* and cephalosporin-resistant *E. coli* counts on chicken carcasses (up to $0.8 \log_{10}$). This, alongside sequential use of chilling showed overall reduction effects of around $1 \log_{10}$ for *E. coli* and around $2 \log_{10}$ for cephalosporin-resistant *E. coli*. This indicates that the chicken slaughter processing that incorporates one intervention step is effective in reducing the spread of cephalosporin resistance in the broiler chicken meat chain.

A survey of post mortem meat inspection data collected in a sheep abattoir in North Tunisia

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Post mortem meat inspection is a vital tool used in the protection of public health. The identification of diseases or conditions at post mortem meat inspection results in the condemnation of carcasses or organs, which has a huge economic bearing on farmers and the meat industry as a whole. Data were collected through post mortem meat inspection over a 12-month period between December 2013 and November 2014 at a low-throughput sheep slaughter facility in Beja, Tunisia. Collection of data was paper-based. Of the 118,834 sheep slaughtered over the duration of the study, a total of 126,633 conditions were recorded, which indicates that there were more conditions than the number of animals slaughtered. This is mainly due to the facts that some animals had at least one condition recorded at different locations or two or more conditions were found in one animal. The most common conditions observed during the study were fascioliasis (35.88% of total conditions including total carcass condemnations), and lung lesions (18.75%), all of which accounted for 54.63% of total conditions recorded. Fascioliasis alone was responsible for the condemnation of 16,807 livers, the equivalent of about 3 tonnes with a value of about £13,000. Altogether, 185 whole condemned carcasses were rejected over the 12-month period due to pyroplasmiasis (93.2% of all totally condemned carcasses). A total of 21 carcasses were rejected for other reasons (oedema 18.3%, tumours 0.26% and severe trauma 0.9%).

Assessment of risk to humans related to *Salmonella* in bile on pig carcasses

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In the European Union, *Salmonella* is the main zoonotic hazard in pork. Contamination may occur during slaughter, e.g., due to spread of fecal material. In 2020, the Danish competent authorities (CA) raised the concern that bile contamination of pig carcasses could be related to exposure of humans to *Salmonella*. To address this, it was decided to study the prevalence of *Salmonella* in pig bile.

The study was composed of two parts; an initial pilot study during which an aseptic way of taking samples from gall bladders was developed. This was followed by collection of 299 gall bladder samples from finishing pigs from 28 Danish pig herds. The samples were subjected to standard laboratory investigation. None of them were positive for *Salmonella*. A simulation model was set up to simulate the number of carcasses contaminated with *Salmonella* from bile that could be overlooked if the responsibility for handling bile contamination were to rest solely with the food business operator (FBO). The parameters for the model originated from the collected data, the Danish meat inspection database and expert opinion, retrieved from the CA and FBO. Two scenarios were run, a basic and a worst-case.

According to the basic scenario, a median of nine (90% CI: 0-53) carcasses would be overlooked in the production of 16 million finishing pigs in 1 year. Similarly, 103 carcasses (90% CI: 7-544) would be overlooked in the worst-case scenario. Compared to the Danish *Salmonella* programme, the median relative efficacy of focusing on bile-contamination to detect *Salmonella* was 0.008% in the basic scenario and 0.087% in the worst-case scenario.

In conclusion, the risk to human health associated with *Salmonella* resulting from bile contaminated finishing pig carcasses was estimated as negligible. Moreover, the FBO has procedures in place to prevent bile contaminated carcasses from leaving the abattoir.

The risk assessment was presented to the Danish veterinary authorities which sent it for external review at the Danish Technological University. In January 2022, the Danish veterinary authorities decided to change the official view regarding the importance of bile contamination on finishing pigs, so this will no longer be considered a potential human health hazard.

Study of the presence of *Echinococcus* cysts in bovine carcasses in a public slaughterhouse in Tirana

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Echinococcosis is among the diseases in the World Organization for Animal Health (OIE) list, and for this reason, it should be reported by member states according to the OIE code. It is a zoonotic disease and has great general and economic health importance.

This study will address general data on the disease and its active presence in a public slaughterhouse in Tirana, Albania. The study was conducted in Arbana, part of the district of Tirana, 9.3 km from the center of Tirana.

The study sample included 104 cattle that were slaughtered and inspected during May 2019, in the aforementioned slaughterhouse. The study also included the data from the veterinary inspection registers, wherein 954 cattle, were slaughtered and inspected, during the period June 2018 - April 2019.

Specific checks were undertaken for each carcass that entered the slaughterhouse. Cattle were divided into two age groups: under 36 months and over 36 months (in order to detect the age influence on the possible appearance and distribution of *Echinococcus* cysts).

During May 2019, out of the 104 slaughtered cattle, 4 (3.8%) were found to have *Echinococcosis*. Out of 954 inspections carried out during June 2018-April 2019, 8 (0.8%) carcasses had *Echinococcus*. In total, from 1058 (954 + 104) carcasses of cattle inspected during the study period, 12 (1.1%) carcasses harbored *Echinococcus* cysts

All cattle carcasses with *Echinococcus* cysts were under 36 months of age. Bovine carcasses with *Echinococcus* cysts originated from Fier (23%), from Lushnja (25.9%), from Berat (29.8%) and from Tirana (21.1%). The carcasses that had *Echinococcus* cysts in May 2019 inspections were all from Berat (4 carcasses).

In the post mortem control and inspections performed in May 2019, the carcasses appeared non-cachectic, without edema of muscle tissue. In these instances, only the organs where cysts were found were obtained for further analysis, i.e., lungs and liver.

In the liver there were 130 cysts, out of which 112 (86.2%) were calcified, while in the lungs there were 123 cysts, out of which 22 (17.8%) were calcified.

Since hydatid cyst is a risk factor for human health, it is necessary that health policy makers make effective decisions in relation to this disease and implement accurate inspections by health experts and authorities.

Assessment of the hygiene and food safety criteria for the rabbit slaughter process

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The hygienic dressing of rabbit carcasses in the slaughterhouse is a key element to prevent meat contamination resulting from poor hygienic practices or cross-contamination between clean and unclean areas. Strict monitoring of animal welfare conditions and proper animal handling are key elements to reduce the generation of stress in pre-slaughter operations and, therefore, facilitate the reduction of growth of pathogenic microbial organisms on carcasses. The monitoring of hygienic slaughter can be verified by microbiological control of the processes through the control of indicator organisms. Regulation 2073/2005 sets legal limits for ruminant and porcine carcasses, but not for lagomorphs.

The objective was to compare the levels of microbial contamination in different locations of rabbit carcasses sampled in a small production slaughterhouse. For this purpose, four sampling sessions (19/01/2018, 14/02/2018, 5/03/2018 and 19/03/2018), analysing five randomly selected carcasses using the non-destructive method to determine mesophilic aerobic bacteria and *Enterobacteriaceae* by swabbing with sterile 0.85% NaCl solution, in areas of 20 cm² in neck, thigh, back and belly locations with the use of a template and rubbing for five seconds in three different directions. For non-destructive sampling for *Salmonella*, an abrasive sponge was used and rubbed in three directions and added to a tube containing 40 ml of sterile saline solution. Forty surface samples for mesophilic aerobes (tryptone soy agar; TSA) and *Enterobacteriaceae* (MacConkey agar) and five samples for *Salmonella* (brilliant green agar) were streaked for 48-72 hours at 37°C.

The highest mean values of mesophilic aerobic bacteria and *Enterobacteriaceae*, respectively, found in each carcass location were: neck (77.95 & 3.4125 CFU/cm²), belly (22.006 & 0.9725 CFU/cm²), thigh (10.14 & 0.5612 CFU/cm²) and back (6.15 & 0.4325 CFU/cm²). The analysis of variance (ANOVA) determined statistically significant differences ($\alpha=0.05$) in bacterial numbers on the neck with respect to the thigh and back. Regarding *Salmonella*, the presence of bacteria was not detected in the samples analysed.

Consequently, it can be concluded that neck, belly and thigh are the carcass locations of choice for sampling rabbit carcasses for the estimation of contamination by mesophilic aerobic bacteria and *Enterobacteriaceae* as hygienic criteria for slaughter processes.

Assessment of the prevalence of microbial antibiotic resistance in rabbit slaughterhouses

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In order to investigate the prevalence of antibiotic-resistant bacteria in a rabbit slaughterhouse, animal and process area surfaces were analyzed in the present study. Rabbit carcass surfaces are a suitable substrate for growth of pathogenic microbial bacteria due to improper animal handling from the slaughtering and the processing of carcass. Unhygienic slaughtering drives contamination of carcasses, which have microorganisms present in their skin, hair/wool, noses, urogenital and oral cavities, and besides, inside their intestinal tract. In this sense, contamination with antibiotic-resistant bacteria may increase the risk of resistance gene spread, especially in the gut microbiome where horizontal transfer of resistance traits may take place between commensals and pathogens. This fact is enhanced by antimicrobials (antibiotics and biocides) used for different purposes in animals or the slaughterhouse environment. The WHO Global Action Plan on Antimicrobial Resistance (2016) included surveillance and monitoring strategies of antibiotic resistance in farm animals and foodstuffs, in order to develop new measures to combat this resistance. The aim of this study is to determine the prevalence of antibiotic resistant bacteria on carcass and environmental surfaces in a small production rabbit slaughterhouse. For this purpose, two rounds of sampling were carried out (February and March 2018) with a total of nineteen samples recovered in triplicate. In the first round, ten surfaces, not in contact with the carcasses, but close to the dressing and storage area, were sampled. The second round sampled two rabbit carcasses, three tool and four installation surfaces. The non-destructive sampling method was performed by swabbing with sterile 0.85% NaCl solution in 5 cm² areas, with the use of a template, and rubbing for 10 seconds in three directions. With the aim of isolating antibiotic resistant bacteria (ABR), the resulting swabs were immersed in brain heart infusion (BHI) medium or tryptone soya broth (TSB) containing tetracycline, amoxicillin or sulfamethoxazole and incubated at 37°C for 24 h. Cultures were serially diluted in sterile saline solution and plated in triplicate on tryptone soya agar. Counts were obtained after 48 h of incubation at 37°C for estimation of antibiotic resistant aerobic mesophilic bacteria. The preliminary identification of resistant colonies was carried out by Gram staining and microscopic observation of colonies. Enterococci, *Enterobacteriaceae*, Gram+/- cocci and Gram+ *Staphylococcus aureus* were investigated. The results obtained showed that 7.92% of the bacteria isolated were resistant to tetracyclines, in line with the 8.0% reported in Spain (2016). 57.14% of the bacteria isolated in different locations of the slaughterhouse, like slaughtering room, evisceration area, chilling chamber, packing room and box store, were antibiotic-resistant) and carcasses showed 10.84% of the bacteria isolated were antibiotic-resistant, although, in general, a higher prevalence of bacteria resistant to sulfamethoxazole and amoxicillin was observed on the carcasses. From this study, we can conclude that surfaces of equipment, installations and carcasses are the main reservoirs of ARB, potentially leading to antibiotic resistance spread to humans and the environment and, thus, causing a great public health challenge.

The non-rational use of antimicrobials for veterinary or production purposes is a clear threat to animal and human health from a One Health perspective and highlights the problem of antibiotic effectiveness and bacterial resistance.

Evaluation of indicators to support risk-based meat inspection in poultry

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Meat inspection is essential to food business operators' compliance with regulatory requirements regarding protection of human and animal health and animal welfare. Practical arrangements for *post mortem* inspection (PMI) of poultry are defined in article 25 of the Implementing Regulation 2019/627. PMI procedures should be risk-based, with necessary additional procedures when there is reason to suspect that the meat from inspected birds could be unfit for human consumption.

The main objective of this study was to assess the usefulness of potential indicators that may assist the official veterinarian (OV) in implementing a risk-based PMI. For this purpose, meat inspection was conducted on 38 broiler flocks (243,282 animals). In these broilers, the associations were studied between the total condemnation by disease (TCD) and the following potential risk-indicators: age, weight, cumulative mortality rate (CMR), deaths on arrival (DOA) and time before slaughter (TBS). Spearman's Correlation was performed using the statistical software SPSS (version 22.0). This study identified a positive association between the TCD and each of age ($r=0.271$; $p=0.016$), weight ($r=0.276$; $p=0.014$), CMR ($r=0.282$; $p=0.013$) and deaths on arrival ($r=0.314$; $p=0.005$). Of these TCD indicators, the CMR, which is indicated in the food chain information and can be seen before the slaughter of each flock, appears to be very useful as an indicator in a risk-based meat inspection approach. The worse the CMR, the more time the OV must dedicate to the PMI of that flock. The deaths on arrival, despite showing a higher statistical value correlation than the CMR, are impractical to use, as the OV only receives the true value of this indicator at the end of the flock slaughter. However, it can be used as a good animal welfare indicator. These results suggest that further studies should be conducted for more accurate assessment of the usefulness of employing the CMR as an indicator for *post mortem* risk inspection. In the future, more studies should be conducted on risk-based inspection.

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Importance of traumatic injuries observed during the *post-mortem* inspection of broilers

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The implementation of Directive 2007/43/EC requires the use by official veterinarians (OV) of an assessment system for poultry welfare at the slaughterhouse level. For this purpose, there are several parameters that can be analysed by OV, such as traumatic injuries. Despite this, in some countries, such as Portugal, injuries are only assessed and recorded when they are extensive and associated with total condemnations. For this reason, the main objective of this study was the detailed characterisation of all traumatic lesions observed during the *post-mortem* inspection (PMI) of broilers. For this purpose, during meat inspection of 38 broiler flocks (243,282 animals), the following parameters regarding traumatic injuries were analysed: location (e.g. thigh, leg, breast), dimension, age of injury and presence/absence of fracture. As the main results, the authors would like to underline that the percentage of injuries was 2.87% (N=2872). From this, 56.89% (N=1634) of birds presented a fracture too, and the majority were caused *ante-mortem* (82.93%; N=1355). These fracture injuries mostly affected the wings (with 83.85% of the breakages), while 67.45% of the injuries were recent (± 2 minutes), which reveals problems during the hanging of the broilers on the slaughter line. Furthermore, almost all (97.57%) of the resultant carcasses were subjected to partial condemnation; this type of condemnation is not recorded by OV and for that reason, recorded figures do not represent the reality of this injury in broilers. Besides that, in economic terms, trauma injuries associated with partial condemnations ($\pm 67802\text{€}/\text{year}$) have a higher impact than the injuries associated with total condemnations ($\pm 25919\text{€}/\text{year}$). These results allow us to understand the importance of assessing in more detail the traumatic injuries as indicators of animal welfare, in order to implement more targeted mitigation strategies (e.g. during hanging, catching) to correct specific animal welfare problems and economic losses. It is also important to establish a maximum limit for this parameter. More studies should be developed to evaluate the main risk factor related to traumatic injuries.

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Retrospective analysis of broiler carcass condemnations in Portuguese abattoirs (2014- 2019)

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Meat inspection is one of the most widely implemented and longest running systems of surveillance. It was primarily introduced to identify specific characteristics in the meat of animals that are not fit for human consumption and to remove their carcasses and offal from the food chain. In the poultry production industry, various diseases and many pathological changes can affect these carcass characteristics. This leads to economic losses due to total or partial condemnation of carcasses or viscera following veterinary evaluation at the time of slaughter. The aim of this retrospective analysis was to determine the economic losses of broiler carcass condemnation during a 9-year period in Portugal, based on the Portuguese official published data related to slaughtered poultry from January 2014 to December 2019. The data, including the total number of broilers slaughtered, total condemnation rate (TCR) and number of those condemned for specific conditions, were used as a source for this analysis. The direct economic losses due to poultry carcass condemnation were calculated using the following formula: $DFL = C \times P \times W$, where: DFL - direct financial loss; C - number of condemned poultry carcass; P - average poultry carcass price (€/Kg); W - average poultry weight (Kg). The annual average sell price (P) for each kilogram of poultry carcass was calculated by taking the average of the values officially published each week. A total number of 1,167,995,335 broilers were slaughtered in Portuguese abattoirs in the considered period, and the total rate of carcass condemnation was 1.05% (12,310,212). The five most common reasons for carcass condemnation (excluding those attributable to the slaughter operations) were cachexia (25.4%), septicemia/febrile state (20.4%), cellulitis (11.4%), airsacculitis (7.7%), ascites/hydroemia (6.9%). The estimated averages of total direct financial losses were: 7.9M€ due to cachexia, 6.9M€ to septicemia/febrile state, 3.8M€ to airsacculitis and almost 2.4€ to ascites/hydroemia. These results allow a more detailed analysis of the economic importance associated with the post-mortem condemnation of broilers, and can assist and inspire food business operators to prioritize the application of tailor-made and effective control measures.

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Association between gastric lesions at the slaughterhouse and anti-inflammatory drug use in Italian heavy pigs

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Gastric lesions, a major issue in the pig industry, are caused by several factors, among which the usage of steroidal and non-steroidal anti-inflammatory drugs (NSAIDs) may play an important role, although poorly investigated. The aim of this study was to explore the relationships between the estimated use of anti-inflammatory drugs at farm-level and the presence of gastric lesions in heavy pigs (slaughtered at ~170 kg live weight) at the slaughterhouse. The study was conducted in two commercial slaughterhouse located in Northern Italy in the period between October and December 2019. Batches of animals and pigs within-batch were randomly selected, and the stomachs were assigned to four gastric score categories based on the severity of the lesions (0=No lesions; 1=Hyperkeratosis; 2=Erosions; 3=Ulcers). Data on the use of anti-inflammatory drugs and farm size (number of pigs reared per year) were collected via the Italian CLASSYFARM System and the Italian Veterinary Database, respectively. The usage of anti-inflammatory drugs was estimated for each farm by calculating a treatment incidence 1000 (TI₁₀₀₀), which is the number of pigs under treatment with a specific active ingredient, on a given day, for each 1000 pigs housed in a farm. The correlation between anti-inflammatory drug consumption (expressed as TI₁₀₀₀) and farm size was tested through Spearman's rank correlation. The variation in the farm-level scores of gastric lesions was analysed by a linear mixed model, with drug consumption values as explanatory variables and farm size as a random slope. Overall, the stomachs of 4184 pigs from 36 farms were included in the study, with 17.2%, 31.7%, 45.5% and 5.6% of them assigned a gastric score of 0, 1, 2 and 3, respectively. At least one prescription of anti-inflammatory drugs was found in 29 out of 36 farms (80.6%). The median TI₁₀₀₀ of anti-inflammatory drug consumption was 0.45 (range: 0–31.6). NSAIDs were used on 20 farms (55.6%) with a median TI₁₀₀₀ of 0.07 (range: 0–30.1), while steroids were administered on 23 farms (63.9%) with a median TI₁₀₀₀ of 0.18 (range: 0–6.2). Gastric scores were positively associated with NSAIDs TI₁₀₀₀ (parameter estimate±SE = 0.032±0.015; F_{1, 32}=4.38; p=0.044), while steroid usage had no significant effect on the presence of gastric ulcers. The results of this study show that NSAIDs should be carefully administered considering all the potential risk factors for gastric lesions. However, their use needs to be encouraged as a possible strategy to reduce antimicrobial consumption and improve animal welfare in pig farms.

The influence of tail biting on pig carcasses considering different production systems and tail length

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Tail biting is recognized as a major welfare issue in pig production, associated with great economic losses. The European Union has stated its position regarding tail docking practices through the Directive 120/2008/EC and Recommendation (EU) 2016/336. The directive encourages all Member States to establish standards for the protection of pigs as well as measures to reduce the need for tail-docking and tail biting prevalence. This study aims to evaluate tail biting occurrence in slaughtered pigs, analyse the association of tail lesions with production system and tail length, and explore the relationship between carcass condemnations and tail damage. Information on a total of 9189 pigs from 73 batches with different tail lengths (undocked, docked mid-length, fully docked) and from distinct production systems (conventional, conventional without the administration of antimicrobials, organic) was collected at a Spanish abattoir. Due to the speed of the slaughter line, it was only viable to classify a subset of 3636 animals regarding their tail condition, which was classified into three categories. Batches with higher lesion scores presented a greater chance of total condemnations ($p=0.014$, $OR=1.81$) and total condemnations by pyaemia ($p=0.013$, $OR=2.96$). The probability of observing tail lesions varied with tail length, with undocked pigs having higher odds of showing severe lesions when compared to the other tail lengths ($p=0.0001$, $OR=3.11$ and $OR=2.10$). When it came down to local condemnations due to abscess, tail length was also significant with docked at mid-length and undocked carcasses having higher odds of abscess condemnations than fully docked ($p=0.0002$, $OR=2.10$ and $OR=1.70$). Regarding husbandry systems, organic farms had a higher probability of total condemnation when compared to the other two production systems ($p=0.0263$, $OR=2.27$ and $OR=4.36$). This research concludes that there is a clear association between tail lesions and condemnation rates. As tail length influenced the severity of tail lesions, it is imperative to consider the impact of tail length on animal welfare and conduct further studies to determine if a longer resected tail could result in more favourable outcomes compared to a conventional docked tail. Although it is argued that pigs raised under less intensive production conditions (organic) have a higher level of animal welfare compared with pigs raised under conventional production, tail biting and systemic infections can still be observed in organically raised pigs.

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Importance of using a scarring score to classify tail biting lesions on pigs' carcasses at the abattoir

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Tail biting has been recognized as an emerging problem in pig production. During meat inspection, tail assessment can be challenging and lead to an underestimation of the real tail biting prevalence at the farm since the current method of evaluation only accounts for a scale related only to fresh/recent wounds. By the time the pig reaches the abattoir, some tails can appear to be healed, but that does not exclude the fact that there might still be an underlying ongoing infection with the presence of deep abscesses. Besides, since it can take up to several weeks for the abscesses to develop in the vertebral column, it is possible to detect during post-mortem inspection carcasses with both purulent osteomyelitis and a healed tail. This study aims to evaluate tail biting occurrence in slaughtered pigs, explore the relationship between carcass condemnations and tail damage and assess the importance of creating a more detailed tail score classification that includes scarred lesions. Information on a total of 9189 pigs from 73 batches was collected at a Spanish abattoir. Total and partial carcass condemnations were registered from the total population. Due to the speed of the slaughter line, it was only viable to classify a subset of 3636 animals, who had their tail classified by two scores: the lesion score (relating to recent tail lesions) and the scarring score (which evaluated only scarred tissue). Batches with higher lesion scores had a greater chance of total condemnation ($p=0.014$, $OR=1.81$), and were even more associated with scarred lesions ($p=0.0002$, $OR=3.24$). Pyaemia was influenced by recent lesions ($p=0.013$, $OR=2.06$) and had an even stronger relationship with scarring scores ($p=0.0002$, $OR=3.86$). The within-batches probability for local condemnation due to abscesses ($p<0.0001$, $OR=3.65$) increased significantly with higher scarring scores. This research concludes that scarred tail lesions have a close relationship with total condemnations and with local condemnations due to abscesses. The scarring score displayed a more relevant role than the scoring system for recent lesions, which proves that scarred tissue can also work as a welfare indicator regarding farm conditions and should be included in the tail surveillance program.

Correlation between airborne bacteria, carcass dirtiness and hygiene indicators of bovine carcasses in the slaughterhouse environment

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Escherichia coli is one of the hygiene indicators evaluated in the slaughterhouse environment. Cattle are the main reservoirs, being asymptomatic shedders since *E. coli* is a commensal of their digestive tract. From this, it can be deduced that faeces are the main way by which skin and meat can be contaminated. Furthermore, the amount of soiling and visible dirt on the skin of the animal, at slaughterhouse level, are possibly related to *E. coli* contamination. Therefore, clean animals at the slaughterhouse along with good hygiene practices during slaughter are essential requirements to avoid or reduce carcass contamination and guarantee food safety. Our study aims to demonstrate the correlation between visible contamination of the carcasses and microbial levels in slaughterhouse aerosols with the hygiene level, evaluated by laboratory techniques. During our study, total mesophilic aerobic bacteria and *E. coli* were enumerated. An innovative method was applied to determine the visible contamination of carcasses, such as hairs and faecal specks, by using a 100 cm² sheet of transparent adhesive plastic material applied on the side of the carcass to collect all particles, which were then counted first against a black and then against a white background. Airborne bacteria in slaughterhouse aerosols were determined by an EasySPT air sampler. The device, typically used for the airborne microbiota monitoring, has a suction flow of 10 L/min. Three Petri dishes with selective media were placed in the machine suction chamber to evaluate three different bacterial populations: total mesophilic aerobic bacteria, *Enterobacteriaceae* and enterococci. A linear regression was performed to determine the correlation of visible contamination of the carcass and bacterial load of the aerosols with the results of the microbiological analysis. A total of 249 carcasses were sampled. The mean values of total aerobic bacteria and *E. coli* were always under the upper limit provided by the regulation. Sixty carcasses, out of 249 (24%), were positive for *E. coli*. Statistically significant correlations of visual dirtiness score and microbial levels in aerosols were observed with bacterial counts. These results are of the utmost importance to streamline the control practices for hygiene criteria of production processes in slaughterhouses by lessening the expensive and time consuming routine procedures of laboratory analytical methods.

Legislative framework for meat inspection system in Croatia

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This paper describes the changes in the Croatian regulations and harmonisation with European Union (EU) legislation in the field of meat inspection, before and after 2013, when Croatia joined EU. Namely, in the last 30 years, the legislative framework of the meat inspection system in Croatia has changed several times. In 1997, the Veterinary Act (OG 70/1997) stipulated that veterinary health inspection in slaughterhouses is carried out by authorised veterinarians (AVs) employed in veterinary organisations to which state authorities have been delegated, while officinal veterinarians are employed by government and have a broader spectrum of duties. The AV performed the veterinary examinations to determine the safety of products of animal origin, and only they, and not the food business operators (FBOs), were responsible in the case of any non-compliance. The conditions that AVs had to fulfil were a diploma from the Faculty of Veterinary Medicine, a certificate of completion of the State Professional Examination (SPE) for Veterinary Inspector, and at least three years of professional experience after passing the SPE. The next Veterinary Act (OG 41/2007) brought changes in the meat inspection in the framework of official controls of food of animal origin by dividing regulations between this Act and the Food Act (OG 46/2007), and introduced the term “control bodies” for veterinary organisations with delegated state authorities. An AV then had at least two years of professional experience, a license (issued by the Croatian Veterinary Chamber after completing one year of professional practice) and the SPE certificate (issued by the Minister of Agriculture). The Food Act introduced a shift of responsibility in the case of non-compliances to FBOs, at all stages of production, processing and distribution. The Veterinary Act of 2013 (OG 82/2013) implemented Regulation (EC) No 882/2004 in the Croatian legislative framework, but did not bring any changes related to meat inspection. The State Inspectorate Act (OG 115/2018) introduced significant changes in the organisation, as all inspections involved in the food safety system were merged, with the exception of fisheries inspections. The Act on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products (OG 52/2021) implemented the provisions of Regulation (EU) 2017/625. The State Inspectorate was introduced as the Competent Authority for different areas of official controls, and “delegated bodies” as the local competent authorities performing meat inspection. At the same time, amendments to the Veterinary Act (OG 52/2021) changed the requirements for AVs. The development of the legal framework over the years had less impact on the methodology of meat inspection, so risk-based meat inspection did not play a role in practice. However, since 2013, in cooperation with the Faculty of Veterinary Medicine and the Croatian Veterinary Chamber, continuous training programs have been organised for AVs, based on the EFSA scientific opinions (2011-2013) on public health hazards posed by meat and its control in meat chain.

Selected microbiological risks of chicken breast muscle myopathies in relation to physicochemical and histopathological changes

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Intensive selection of poultry toward increasing the growth rate and meat production has led to a more frequent occurrence of metabolic defects. New disorders appeared, such as white striping, wooden breast, fibrosis of the connective tissue and so-called spaghetti meat, disqualifying or significantly reducing the safety, quality and processing value of meat (Maiorano, 2017). Meat structure, resulting from the presence of muscle fibres, the proportion and distribution of connective and fat tissues (Taylor, 2004), as well as production sustainability, microbiological safety, i.e., the absence of pathogenic organisms and toxins (Kołozyn-Krajewska, 2010), animal health and welfare are among the most crucial aspects in meat production nowadays. Zhang et. al., 2021 stated that the chicken ceca microbiota may be associated with the development of muscle myopathies and woody breast.

The aim of the study was to analyse physicochemical and histopathological changes and to evaluate selected microbiological risks of chicken breasts with myopathies or defects. The study included visual determination of the occurrence of quality defects, physicochemical analysis of the breast muscles, microbiological evaluation and determination of antibiotic resistance of selected bacteria isolated from the intestinal contents of broiler chickens. Changes in colour parameters and pH were observed in the breast muscles of chickens with meat quality defects. In defective meat, especially with bloody bruises, after electrophoretic separation, clear bands are observed on the stained polyacrylamide gel corresponding to protein substances with a molecular weight above 60 kDa, which are not visible in meat without defects. In the case of meat with white stripes, additional bands of proteins with a mass of approx. 220 kDa can be observed. Statistical analysis of the intestinal microbiota of broiler chickens proved that the presence of petechiae can be correlated with the reductions in the amount of beneficial *Lactobacillus* spp. There was no correlation between the number of enterococci and *Escherichia coli* in the intestinal microbiota of chickens and the appearance of myopathy in poultry, nor between the MIC values of colistin, cefotaxime or meropenem responsible for antibiotic resistance in *Escherichia coli* isolates.

Antimicrobial resistance in *Escherichia coli* isolates recovered from a pig slaughterhouse line in Serbia

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The aim of the present work was to investigate the prevalence of antimicrobial resistance of *Escherichia coli* isolates and especially the presence of multidrug resistant strains within a pig slaughter line. The prevalence and transmission of antimicrobial resistant microorganisms has been recognized as a serious global public health problem. *E. coli* is generally present on pig carcasses, and it is widely used as an indicator of fecal contamination. Moreover, some serotypes are pathogenic. In Serbia, antibiotics are used for bacterial disease therapy and as growth promoters in subtherapeutic doses. The quality and safety of pork are of high interest since pork is widely consumed in Serbia. An assessment of cross-contamination events was performed by monitoring the presence of *E. coli* along the slaughter line. Sampling was performed in a medium scale slaughterhouse processing a maximum of 1000 pigs per day. Pigs were obtained from different small- and medium-sized pig farms. Sponge sampling of 16 pig carcasses and six environmental surfaces was performed. Determination of antimicrobial resistance of the *E. coli* isolates found was performed by the disk diffusion method, and 14 types of antibiotics were used. The results showed that *E. coli* was isolated from 86.4% of the 22 swabs taken. The proportion of antimicrobial resistant isolates was 84.2 %. The presence of multidrug resistance (defined as resistance to three or more antimicrobials) was detected in 52.6% of the isolates. Resistance was registered for tetracycline (63.2%), ampicillin (52.6%), streptomycin (47.4%), chloramphenicol (36.8%), trimethoprim (31.6%), trimethoprim-sulfamethoxazole (31.6%), nalidixic acid (15.8%), cefpodoxime (5.3%) and cefotaxime (5.3%). All isolates were susceptible to ceftazidime, ciprofloxacin and gentamicin. The profiles of antimicrobial resistance varied between the eight different sampling sites, which suggests that some process stages lead to decreases and some to increases in number of antimicrobials to which isolates showed resistance. The largest number of antimicrobials to which isolates showed resistance was 11, in isolates from the stunning box. It is very important to maintain the microbiological quality of all equipment surfaces from slaughterhouse operations in proper condition to reduce the prevalence of *E. coli*, including the multiresistant strains. Proper hygienic measures are the main prerequisites for preventing the spread of antimicrobial resistance within slaughterhouse lines and, consequently, through food chain. More analyses are required in order to identify the transmission of antimicrobial resistance from contact surfaces to and critical control points in cross contamination within the slaughter line.

Epidemiology of methicillin-resistant *Staphylococcus aureus* in nasal cavities of slaughtered small ruminants in a Greek abattoir.

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Methicillin-resistant *Staphylococcus aureus* (MRSA) is a universal threat. After being well-established in the healthcare setting, it has emerged also in the community. The subsequent detection of MRSA colonizing or infecting animals as well as in food of animal origin is of major concern, revealing new reservoirs for MRSA. The aim of the study was to estimate the prevalence of MRSA in ruminants at slaughter in Greece and to use the results as a baseline study to perform microbial risk assessment. Nasal swabs were collected from 30 goats (originating from three different farms, 10 animals per farm) before slaughter in an abattoir in Thessaloniki, Greece. From each sample, four presumptive *Staphylococcus aureus* (*S. aureus*) colonies were selected for molecular confirmation, antimicrobial susceptibility testing and genetic characterization (*mecA* and *mecC* genes, virulence-associated genes, *Staphylococcus enterotoxin* genes, assessment of biofilm-formation ability and *spa* typing). *S. aureus* and MRSA were detected in 19/30 (63%) and 1/30 (3.3%) of the sampled animals. The detection rate for *S. aureus* in the animals differed on the three farms (farm A=100%, farm B=80% and farm C=10%). One MRSA isolate was detected, harbouring the *mecA* gene, whereas the *mecC* and Panton-Valentine Leukocidin (PVL) genes were not detected. The MRSA isolate was assigned to *spa* type t13336, harbouring *seb* and *sed* genes. This isolate showed resistance to penicillin, oxacillin, trimethoprim, tetracycline and amoxicillin/clavulanic acid, while it was found to be a weak biofilm producer. PFGE subtyping for MRSA did not reveal any connection with other pulsotypes (originating from food animals, milk, meat and humans) present in the laboratory's pulsotype database. However, this is a small database consisting of a few hundred strains isolated from all over Greece. The results of this (preliminary) study point to small ruminants constituting a possible risk for the dissemination of MRSA into the community. More work is needed in the field to estimate the prevalence of MRSA in goats and other ruminants at farm and abattoir levels. However, a study like this can be used as a baseline study in quantitative microbial risk assessment to estimate the impact of small ruminant MRSA carriage in the food industry and for public health purposes.

Supervision of the official control of food of animal origin from third countries: the case of gizzards from Brazil at the border control post of Lisbon's port in 2020

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European Union (EU) food safety policy provides the framework for a high level of public health protection. Upon arrival at the European market, food items of animal origin from third countries must comply with a set of legally enforced requisites with the goal of safeguarding food safety and public health. Each Member State is responsible for certification of compliance, which is carried out at Border Control Posts (BCP). In the BCP, all consignments arriving to the EU from third countries must be controlled by official veterinarians. In specific cases, additional control measures may be used, such as Safeguard Measures. This work had the main aim of supervising the official controls carried out by official veterinarians on imported consignments of products of animal origin into the EU from third countries at the BCP of Lisbon's port throughout 2020. More specifically, the compliance of requirements related to the importation of frozen chicken gizzards from Brazil was assessed. This study compliance of official control procedures related to the abovementioned consignments. In all studied consignments, the controls were carried out with satisfactory results. Still, different non-conformities in the filling of the Common Health Entry Document (CHED) and Common Veterinary Entry Document (CVED) were identified, namely in 7 Boxes of the CHED-P and in 11 Boxes of the CVED-P, most of them of minor seriousness. Non-compliances of this nature in the issuing of these Entry Documents were also observed in audits carried out by the European Commission on European BCP's in 2017. Nevertheless, most non-conformities occurred due to the transition of the online certification system platform, from Classic TRACES to TRACES NT. Current EU official controls supervision results from the assessment of food safety policies enforcement, and thus, of an in-depth knowledge of these policies.