

Report of the Scientific Committee of the Spanish Agency for Food Safety and Nutrition (AESAN) on cases that require additional procedures alongside the routine *post-mortem* inspection in slaughterhouses

Reference number: AESAN-2021-002

Report approved by the Scientific Committee in its plenary session on 17 february 2021

Working group

Carlos Manuel Franco Abuín (Coordinador), Carlos Alonso Calleja, Pablo Fernández Escámez, Elena González Fandos and David Rodríguez Lázaro

Scientific Committee

Carlos Alonso Calleja Universidad de León	Rosa María Giner Pons Universitat de València	Sonia Marín Sillué Universitat de Lleida	Magdalena Rafecas Martínez Universitat de Barcelona
Montaña Cámara Hurtado Universidad Complutense de Madrid	Elena González Fandos Universidad de La Rioja	José Alfredo Martínez Hernández Universidad de Navarra	David Rodríguez Lázaro Universidad de Burgos
Álvaro Daschner Hospital de La Princesa de Madrid	María José González Muñoz Universidad de Alcalá de Henares	Francisco José Morales Navas Consejo Superior de Investigaciones Científicas	Carmen Rubio Armendáriz Universidad de La Laguna
Pablo Fernández Escámez Universidad Politécnica de Cartagena	Esther López García Universidad Autónoma de Madrid	Victoria Moreno Arribas Consejo Superior de Investigaciones Científicas	María José Ruiz Leal Universitat de València
Carlos Manuel Franco Abuín Universidade de Santiago de Compostela	Jordi Mañes Vinuesa Universitat de València	María del Puy Portillo Baquedano Universidad del País Vasco	Pau Talens Oliag Universitat Politècnica de València
Technical Secretary Vicente Calderón Pascual			

Abstract

Commission Implementing Regulation (EU) 2019/627 has taken into consideration the scientific opinions of the European Food Safety Authority (EFSA), which recommends that, where possible, the application of palpation and incision procedures in a systematic manner during *post-mortem* inspection of animals subject to routine slaughter should be avoided, as this can reduce microbial spread and cross contamination. However, as indicated in Article 24 of said Regulation, in certain cases, palpations and incisions shall be applied in addition to *post-mortem* inspection where one of the following indicates a risk to human health, animal health or animal welfare: 1) the food chain information, controls and other health documents, 2) the findings of the *ante-mortem* inspection, 3) the results of the verifications of compliance with animal welfare rules, 4) the findings of *post-mortem* inspection, and 5) additional epidemiological data or other data from the holding of provenance of the animals. In this regard, the Spanish Agency for Food Safety and Nutrition (AESAN) in collaboration

with the autonomous communities has drafted the “Orientation Guide for Official Control Services on cases in which procedures in addition to routine *post-mortem* inspection are to be carried out at slaughterhouses”, which contains a series of sub-sections for each of the five aspects proposed in the aforementioned Regulation.

The AESAN Scientific Committee has been requested to assess this guide to determine if its application would permit the detection of certain abnormalities and pathologies in the animals and, furthermore, reduce the risk of cross contamination with pathogens in inspection through palpation and incision. The Scientific Committee has concluded that the cases proposed in the guide have been linked in the scientific literature and/or applicable regulations with diseases transmissible to humans or animals and with the production of meat unfit for consumption in full or in part. Therefore, it would be appropriate to include them as guidelines for conducting procedures in addition to *post-mortem* inspection in accordance with Commission Implementing Regulation (EU) 2019/627. Some basic formal aspects are also proposed to improve said guide.

Key words

Post-mortem inspection, slaughterhouse, Regulation (EU) 2019/627.

Suggested citation

AESAN Scientific Committee. (Working group) Franco, C.M., Alonso, C., Fernández, P., González, E. and Rodríguez, D. Informe del Comité Científico de la Agencia Española de Seguridad Alimentaria y Nutrición (AESAN) sobre los casos en los que procede realizar procedimientos adicionales a la inspección *post-mortem* de rutina en matadero. *Revista del Comité Científico de la AESAN*, 2021, 33, pp: 53-74.

1. Introduction

The Commission Implementing Regulation (EU) 2019/627 laying down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption (EU, 2019), has taken into consideration the scientific opinions issued by the European Food Safety Authority (EFSA) on the risks for human health that need to be taken into account in the inspection of pork, beef, sheep, and goat meat, soliped meat and farmed-game meat (EFSA, 2011, 2013a, b, c, d). The texts above recommend for palpating and incising to be avoided to the extent possible during the *post-mortem* inspection of animals subject to routine slaughter, as microbial propagation and cross-contamination can thus be reduced. Whereas for the game of the family *Suidae*, for solipeds, and for farmed game the EFSA recommends to solely perform a visual inspection as a general criterion, for bovine animals and small ruminants, the EFSA considers it necessary, depending on the age of the animals, to maintain certain palpation and incision procedures during the *post-mortem* inspection for the purpose of detecting tuberculosis and cysticercoses by *Taenia saginata* in bovine animals, and tuberculosis and fasciolosis in adult ovine and caprine animals.

Complementarily, the Official Veterinary Services should apply the procedures in addition to the *post-mortem* inspection established in the Commission Implementing Regulation (EU) 2019/627 (EU, 2019) which, pursuant to Article 24 thereof, include palpation and/or incision in cases where some of the following elements raise suspicions on the possibility of encountering risks against public health, animal health, or animal welfare:

- The analysis of the food chain information, controls, and other health documentation.
- The result of the *ante-mortem* inspection.
- The results of the verifications of compliance with animal welfare rules.
- The damage that can be observed during the *post-mortem* inspection itself.
- The additional epidemiological data or other data from the holding of provenance.

Given that certain alterations or pathologies cannot be detected merely through a visual inspection, in order to provide orientation for Official Veterinary Services with regard to decision-making at the time to apply the procedures of palpation and incision during the *post-mortem* inspection, the Spanish Agency for Food Safety and Nutrition (AESAN), in cooperation with the autonomous regions, has issued an "Orientation Guidebook for Official Control Services on cases where additional procedures to the routinary *post-mortem* inspection at the slaughterhouse need to be performed" (hereinafter, the Orientation Guidebook). The aim of this report is to evaluate this Orientation Guidebook so as to establish whether the application thereof would allow for certain alterations and pathologies to be detected and for risk to be reduced of cross-contamination with pathogens during the inspection through palpation and incision.

2. Prior Considerations

The performance of a *post-mortem* inspection that is adequate demands, in practice, a correct interrelation between the Official Veterinary Services and the persons in charge of the slaughterhouse, in such a way that the organisation in the pens or area of live animals and what would be considered

the *ante-mortem* phase of the slaughter, is performed according to a specific order established for the animals by the Official Veterinary Services. This order will be decided subject to the risks of the animals after analysing multiple data and information provided by the economic operators. Notwithstanding, the practical aspects in the handling of animals are carried out by the personnel at the slaughterhouse. Thus, animals presenting a higher risk will be slaughtered at the end of their slaughter group (species, age...) with the exception of animals that need to be slaughtered right away for welfare reasons.

For all *ante* and *post-mortem* inspection tasks, it is necessary to comply with the requirements established under Regulation (EC) No. 853/2004 (EU, 2004a) referring to both the facilities of pens and the slaughtering room itself. Likewise, it is the operator's obligation to enable all tasks performed by the Official Veterinary Services, both from a practical handling approach and through the adequate conveyance to such Services of all the relevant information provided by the owners of the animals. This includes food chain information, as well as a review thereof and the conveyance of any other aspect or datum with regard to the animals that may have been discovered by the personnel of the slaughterhouse or other operators which, by virtue of its irregularity or its relevance, needs to be conveyed to the Official Veterinary Services.

On another note, the economic operator needs to have a documented system of self-control where a detailed description of the controls and verifications needs to be set in place as part of their procedures to ensure compliance with the regulation regarding the animals that are going to be slaughtered. In general terms, the operator of the slaughterhouse should have procedures in place that show how to verify relevant animal documentation, including: information and/or documents by the prior owners of the animals, information by the operator who has transferred the animals to the slaughterhouse and the conditions under which this has been carried out, the food chain information, the information on the type of holding of provenance, including information on whether it is an extensive or an intensive regimen, type of production, relevant data of the animals for the production of certified meats, etc.; the identification of the animals, the general state of the animals in appearance, the state of cleanliness of the animals, other welfare aspects, and any other aspect included in this report that can be accessed by the operator of the slaughterhouse. The operator of the slaughterhouse should not only need to document the way to access this information and/or documents, but should also, establish the actions they will carry out in the event of a breach of any requirement. The operator of the slaughterhouse should establish the way in which all the activity referring to the speed of the slaughtering is organised, as well as hygiene aspects, locations in the area of live animals, etc., all this according to the decisions by the Official Veterinary Services for each animal or group of animals.

Based on the above, the assessment of the Orientation Guidebook has been performed through an analysis of the cases proposed for each of the elements that would point to a possible risk for public health, for animal health, or for animal welfare regarding the animals mentioned above that would therefore justify the application of additional procedures of incision and palpation at the *post-mortem* inspection.

As stated in the Orientation Guideline, it must be highlighted that the casuistic included in each of the elements is not exhaustive. Therefore, the Official Veterinarian needs to use their professional

criteria to determine the cases where additional procedures to the *post-mortem* inspection need to be carried out.

The analysis of each of these elements is furthered in the sections below.

3. Aspects related to food chain information, controls and other health documentation, epidemiological data, and other data from the holding of provenance

In Spain, the food chain information regarding the slaughtering of market animals and the epidemiological data or other documents or data from the reference holding are intrinsically linked to one another by reason of the existence of a specific implementing legislation, Royal Decree 361/2009 (BOE, 2009), standardising the food chain information that needs to be indicated by the operator that is the owner of the animals at the time to ship the slaughter animals to the slaughterhouse. Thus, this regulation includes the obligation to state several data referring to other animals of the holding of provenance different from the animals that are being sent to the slaughterhouse at any given time, which implies a *de facto* submittal of other epidemiological data or otherwise from the holding of provenance of the animals. Article 24 of the Commission Implementing Regulation (EU) 2019/627 (UE, 2019) includes both aspects (the food chain information and other epidemiological data) separately for the purpose of assessing the existence of signs of risk for human health or animal health. Notwithstanding, it is stated that, despite the fact that the standard classifies all the cases above into five general sections, in practice, both the food chain information and other epidemiological data can be included within the same section, as they offer one type of homogeneous information that is more objective and allows for more planning, as described in the Orientation Guidebook.

The need for food chain information putting together interesting data so as to decide whether to accomplish a visual inspection or an inspection with additional palpations and cuts was already highlighted more than one decade ago in Europe (Blaħa et al., 2007) (Ellerbroek, 2007) (Windhaus et al., 2007). In addition to the national regulations referred to above on food chain information, EFSA also published some possible harmonised epidemiological indicators back in 2013 regarding this information (EFSA, 2013a, b) so that they could be taken into account at the time to inspect the meat. Other authors also point to some parameters that would need be taken into account for species such as birds in order to establish a food chain information system for the slaughtering of these species (Lupo et al., 2013). In the United States, in view of the European system of “visual-only inspections” in place pork swine since 2014 through Regulation (EU) No. 2014/218 (EU, 2014), the implementation of a system of food chain information was considered essential to decide the type of inspection, either visual-only or with palpations and additional cuts, on a lot-by-lot-of-animals basis (Riess and Hoelzer, 2020). Thus, the need was highlighted for food chain information so as to set in motion the visual-only inspection and, therefore, the fact that, in case of an absence of such information, additional palpations and cuts should be carried out, as envisaged by the regulation, or as the classical veterinary inspection was performed. With regard to food chain information, several studies have been carried out in Europe, such as the study carried out by Gomes-Neves et al. (2018), which analysed this type of information regarding the inspection of meats in Portugal. In

this study, the authors analysed 1694 reports on the food chain drafted between 2015 and 2017, which would cover a total of 79 889 bovine animals and porcine animals, and small ruminants, pointing to an important amount of invalid information that reached 29 % of the total in the case of bovine animals. It can be construed from the above that, if the information collected is not reliable, then such information is not useful. This would classify the animals referred to as animals presenting a greater risk and, therefore, eligible to undergo additional palpations and incisions or to a more detailed inspection. All these documents point to the need of having reliable food chain information in order to adopt decisions on the type of inspection to be carried out.

Analogously to the above, the identification of the animal is directly related to the documentation on the animal. In addition, according to Royal Decree 1980/1998 (BOE, 1998), as part of the identification data, the gender, and the age of the animal are included. Both the gender and the age at the time of the slaughtering of the animals has been proposed as part of the epidemiological studies in animals sent for slaughtering, for the risk to be studied that could be linked to the seizure of bovine animals (Vial et al., 2015). Even when the gender can be identified in a relatively reliable manner in live or slaughtered animals, the identification of the age of the animals during the inspection can be less reliable. Therefore, documents stating the age would be necessary for a fast operation. Doubts about this identification could prevent us from knowing whether the animal falls within the risk parameters and, therefore, whether a more complete inspection with palpations and incisions would need to be carried out. In addition, the age itself conditions the performance of additional cuts and incisions according to the Commission Implementing Regulation (EU) 2019/627 (EU, 2019). Thus, it is essential for this piece of information to be reliable.

The core aspects of the food chain information, such as the security of the data collected and the link of such data to a specific animal based on a reliable identification, implemented and harmonised in Spain through Royal Decree 361/2009 (BOE, 2009) are essential in the assessment of the risk. It must also be noticed that the most remarkable items collected under such information, such as the results for the zoonosis in the last 6 months, the diagnoses of the 12 prior months of diseases that may affect the innocuousness of the meat, or animals treated with veterinary drugs, are items that need to be given the utmost importance during the risk assessment.

The control of the presence of drug residues in the European Union is a core subject in the surveillance of the food chain. Regarding this aspect, there is evidence on a greater incidence of the presence of substances exceeding the Maximum Residue Levels (MRLs) in animals coming from holdings that were previously positive. This can be deduced from the sampling result of the investigation plan with regard to suspects carried out as part of the National Plan of Investigation of Residues, in relation to the sampling directed, carried out simply based on the number of animals (PNIR, 2018).

Likewise, the fact that the animals have been treated presupposes the existence of a pathological process; the most frequent processes being infectious processes which can sometimes be evidenced through additional palpations and incisions. The scientific literature often addresses the subject of residues and pathogenic agents jointly (Kumar et al., 2020) and, in general, a greater presence of drugs is evidenced in animals that were subjected to emergency slaughter. Thus,

important levels of aminoglycoside residues exceeding the MRLs have been found in the kidneys sick pigs subjected to emergency slaughter (Haasnoot et al., 1999). In Cooper et al.'s study (2012), in the case of viscera of bovine animals slaughtered under a regimen of emergency slaughter, up to 17 % of samples positive to anthelmintic drugs was detected with some of them reaching concentrations exceeding the MRL, whereas, for random ones, only 7 % were positive, none of them being above the corresponding MRL. The differences between the percentages of the samples with a presence of residues found in animals that underwent emergency slaughter and the values found in random sampling activities are proof that a relation could be established through a risk assessment between the presence of drug residues (or, in other words, treatments with veterinary drugs) and a greater presence of pathological processes in fresh meats, regardless of the fact that the presence of residues in the meat would already be a risk in itself. All these elements make it completely clear that a relation exists between animals treated with drugs and the diseases of such animals, and the use of additional palpations and incisions for their inspection *post-mortem*.

With regard to animals coming from holdings where diseases have been diagnosed in the last 12 months that can affect the innocuousness of the meat, we would like to bring the attention to the fact that this is indeed a criterion intuitively known to be the basis for the categorisation of animals presenting a greater risk, thus justifying a more detailed inspection. The scientific literature has pointed to the recurrence of diseases such as tuberculosis, indicating the lack of detection of all infected animals, that is to say: at the time to diagnose diseases in the animals of a holding, not all infected animals are detected (Gallagher et al., 2013). In fact, only at the most advanced stages of the infection by *Mycobacterium bovis* in bovine animals important levels of circulating antibodies are generated against this agent, which allows for a more sensitive diagnosis (Pollock and Neill, 2002) (Welsh et al., 2005). It is not only the dynamic of the production of antibodies that justifies the reappearance of diseases in slaughter animals, but also the analytical methods used. Thus, it is common knowledge that a percentage of false positives and false negatives exist in immunoenzymatic essays, so frequently used to diagnose diseases in slaughter animals (Terato et al., 2014). These circumstances, for animals slaughtered at slaughterhouses that come from this type of holdings where processes affecting the innocuousness of the meat have been diagnosed within the last 12 months, serve as a justification for a more detailed inspection to be considered, including additional palpations and incisions. Other various processes affecting the innocuousness of the meat can appear several months after having been considered eradicated (Blancou et al., 2005) (Cantas and Suer, 2014).

In an analogous manner, we would like to point to the case of registering positive results in samples taken within the last 6 months under the frame of control of zoonosis in the holding. The fact must be highlighted, though, that the term zoonosis can probably be construed here in its widest sense, and the importance must be stressed, not only of this type of processes regarding their transmission through meat, but also from the point of view of the origin new diseases in human beings. Thus, it is nowadays known that the appearance of new pathogens in human beings can have a zoonotic origin, and that their presence in animals may alter their pathogenic potential (Cutler et al., 2010). Notwithstanding, despite the fact that the way of transmission of several zoonoses

occurs through several arthropods and, conversely, despite the fact that it is acknowledged that several zoonoses cannot be easily detected at slaughterhouses, it has indeed been highlighted that information coming from farms can be a useful tool when designing strategies that allow for a decrease in their prevalence (Fosse et al., 2008). These circumstances justify the need for animals coming from holdings with positive samples for zoonosis within the last 6 months to be considered animals with a greater risk.

Animals from holdings where infectious or parasitic pathologies have been previously notified that are relevant for Animal Health or for Public Health within the last 12 months (with special attention to zoonoses such as tuberculosis, echinococcosis and others) must be considered animals with a greater risk.

Feedback out of data coming from slaughterhouses is a very important source of information that may be used in risk assessment. This circumstance is not only stressed in publications of regular scientific journals, but also in information that comes from other sources. Thus, for example, we can learn how certain municipalities have specially high levels of impact for some parasitoses (Ruiz, 2017), or even the differential diagnosis of tumours in slaughterhouse injuries (Martínez, 2020). It has also been highlighted that the presence of positive cases of *Mycobacterium bovis* in animals where this pathogen is rarely detected, for example in sheep, is linked to the direct contact of such small ruminants with bovine animals already infected (Broughan et al., 2013). Likewise, the data of the holding of provenance obtained the year before have been decisive at the time to forecast the number of confiscation in the case of porcine animals (Felin et al., 2019). Also, the presence of some parasitic pathologies whose risk can be increased in certain animals would translate into the use of additional procedures, such as in the case of cysticercosis. The presence of a prior cysticercosis can be due to exposure to waters or pastures that entail a risk, or to a certain size of the herd, or even because of the nature of the animals as dairy cattle (Laranjo-González et al., 2016). Obviously, these characteristics will accompany animals from the same holding in the following year, which justifies the use of additional palpation and incision procedures in the *post-mortem* examination. Likewise, in other parasitoses, such as in echinococcosis, the resistance has been registered in the environment of the eggs of this tapeworm in case of finding sufficient humidity, which justifies the reappearance of the echinococcosis cyst in other animals at the holding (Krauss et al., 2003).

A specific case that can also be highlighted is the case of animals coming from holdings where they have been reared under an extensive regimen and are, therefore, in direct contact with the wildlife. In this case, the contact with wild animals has been revealed as an important epidemiological factor in order to detect camelid animals, sheep or other animals with tuberculosis as indicators of having been in contact with bovine animals infected by this pathogen (Broughan et al., 2013). Also in Spain, Parra et al. (2005), using methods of molecular characterisation of *Mycobacterium bovis*, highlighted the dispersing effect of these agents by wild game. A subsequent review by Naranjo et al. (2008) states the existing evidence with regard to the fact of considering boars as reservoirs of tuberculosis, at least in the Mediterranean ecosystem. These circumstances justify the use of additional methods of palpation and incision in the *post-mortem* inspection in case there is a possibility that the domestic animals be in contact with wild animals in extensive holdings.

No reference is needed in order to consider animals that are directly positive within the frame of the National Program of Eradication of Bovine Tuberculosis that is carried out in Spain as animals presenting a higher risk. All the above should be considered for additional palpations and incisions. The classical literature (Moreno, 1991, 2006) already considered the inspection of the lymphatic ganglion as compulsory in all animals with a positive result for tuberculin, although it also notices that many positive animals can be negative with regard to the presence of injuries in the carcass (Moreno, 2003).

Finally, the supervision needs to be considered of animals in holdings subject to certain restrictive or supervisory measures for pathologies of an epidemiological importance. In this section, maybe the best example of the reason why these animals should be considered as animals with a greater risk could be the current emergency of the African swine fever virus, where a greater emergency risk is observed of this process according to the proximity to endemic areas (Bosch et al., 2017). Boars play an essential role in the propagation of this important infectious disease. This is a valid reference to consider animals as animals presenting a higher risk when they are located at areas or farms restricted by reason of their proximity to areas of risk of entry or disease propagation.

4. Aspects related to the conclusions to the *ante-mortem* inspection

By reason of the *ante-mortem* inspection, the decision can already be adopted of performing the *post-mortem* inspection, with additional incisions and palpations of an animal, a portion of a lot, or the integrity of a lot according to the risk assessment. In this case, as indicated in the Orientation Guidebook, the *post-mortem* inspection would need to be carried out to the extent possible at the end of the work day, increasing the hygienic measures and completing a subsequent cleaning and disinfection of the facilities, of the equipment, and of the tools.

This section would include animals that would be considered suspicious after the *ante-mortem* inspection, that is to say, animals that would have an increased risk as a result of showing a temperature, hypothermia, visible lesions such as abscesses or injuries, inflammatory processes such as arthritis, etc., which, subject to the inspectors' criteria, require a more detailed *post-mortem* inspection to verify the extent of said processes vis-à-vis the issuance of an opinion. The majority of the animals that are included in the sections above are correlated with multiple seizures and with involvement in several organic systems. Based on the above, it is essential to discriminate the gravity of the process and whether certainty exists on the fact that what is being dealt with is something of a systemic nature, so as to decide whether a full or a partial seizure is to be performed. The regulation declares systemic diseases or body wasting as a criteria for the full seizure *ante-mortem* (UE, 2019). In this regard, the regulation in the United States indicates temperature values at the time to consider the seizure of an animal (FSIS, 2020). Heinonen et al. (2018) highlight links between the presence of abscesses, many of which can be observed as simple tumours or swellings, easily seen *ante-mortem*, and other processes such as arthritis, pneumonias, and ulcers in sows. Abscesses, arthritis, and other abnormalities, have also been highlighted as having a connection with the partial seizure of bovine carcasses and/or viscera (Dupuy et al., 2014). Every time the possibility exists of a seizure, cuts and palpations need to be performed additional to

the mere visual inspection.

Sometimes, during the *ante-mortem* inspection, the presence can be observed of animals that have apparently not reached the final stage of fattening or whose growth is stunted. In brief, they lack a set of characteristics that match what is expected for this type of animal. At first sight, this type of animals needs to be considered as suspicious, as an economic loss would occur with the conditions observed in comparison to the value expected for the owners, considering that these owners would need to slaughter such animals with a higher weight to reach a higher economic value. In this case, these would be animals that have apparently not reached the final fattening phase. Taking into account the fact that digestive procedures are important diseases in calves (Mötus et al., 2018), namely those reared intensively and with little intake of fibre (EFSA, 2012), growth problems can be considered as elements that are signs of increased risk of several processes. Likewise, the fact of taking into consideration the conformation or the characteristics of the animals based on their race, gender, etc., is essential for a rigorous assessment of the risk, as a greater number of casualties has been linked to the gender, the age, and other characteristics (Mötus et al., 2018). Also, for example, dairy cows have been associated to a shorter lifespan, based on the higher number of health problems they tend to cause (De Vries and Marcondes, 2020).

Regulation (EU) 2016/429 (EU, 2016) establishes five diseases that lead to a risk for human health and for animal safety, together with a longer list of other processes included in the Annex to be reviewed by the Council. These five processes are apthous fever, classical swine fever, African swine fever, highly pathogenic avian influenza and African horse sickness. With regard to apthous fever, the initial points of involvement are the tongue, the pharynx, and the bronchiolar epithelium, the tonsils and the tracheobronchial lymph nodes (Grubman and Baxt, 2004). Classical swine fever (Moennig et al., 2003) or African swine fever (Sánchez-Vizcaíno et al., 2015) also present ganglion involvement, with a variety of clinical signs that can raise suspicions *vis-à-vis* the *post-mortem* examination in the sense that a more detailed inspection would be needed. Analogously, African swine fever presents gelatinous exudates in lymph ganglions, as well as other injuries at kidney level or spleen congestion (Mellor and Hamblin, 2004), all of which request for a more detailed inspection in order to be evidenced. This section is justified, not only by the risk for individuals, but also by the risk for the global cattle industry.

An objective aspect known as well in the *ante-mortem* phase would relate to animals subjected to emergency slaughter outside the slaughterhouse pursuant to the requirements established in Regulation (EC) No. 853/2004 (EU, 2004a). The classical literature includes the suspicion that a greater number was found of toxinfective meats among those generated by animals that underwent emergency slaughter (Moreno, 2003). Bovine spongiform encephalopathy gave rise to the obligation in 2001 of performing rapid determination tests for this disease in bovine animals exceeding the age of 30 months and subjected to emergency slaughter according to the provisions in Decision 2000/764/EC (EU, 2000). A greater number is scientifically confirmed of total diagnoses and seizures in animals slaughtered this way in comparison to animals that did not undergo emergency slaughter (Doherr et al., 2001) (Vial et al., 2015). All these reviews point to the fact that these animals generate a risk that is sufficiently high so as to establish an inspection through additional palpations and

incisions. Likewise, other references establish a greater risk for these meats regarding a greater presence of drug residues in such meats (Cooper et al., 2012), as it has also been referred to in the sections above.

5. Aspects related to the fulfilment of regulations on animal welfare

In principle, we could include two different aspects under this section. First, the fact of detecting any possible process that could make the meat unfit for human consumption, and, secondly, as a measure that is coercive in part, with regard to the fact that the breach of the welfare regulations must lead to progressive action measures with regard to the operators involved (EU, 2019).

As described in the Orientation Guidebook, the breach of these welfare regulations can lead to a state of immunodepression in animals, caused by the stress occurred as a result of an absence of welfare during handling operations. This has been especially linked to enteric pathogens such as *Salmonella* spp., which can migrate outside the intestinal track to other tissues. The relation between animal welfare and the inspection of meats was highlighted by Stärk et al. (2014).

Already the traditional literature on the inspection of meats points to salmonellosis as a transportation disease (Moreno, 1991). Also Duff and Galyean (2007) and Earley et al. (2017) mention so-called “transportation fever” as a process linked to the stress occurred during transportation. Thus, any sign that generates stress in animals, such as:

- uterine prolapse, rectal prolapse, or vaginal prolapse,
- inability to move on their own without pain or unaided,
- serious open wounds,
- physical weakness,
- other signs or symptoms of disease that could render the animals unfit for transportation (tympanites, certain skin problems, vomits, diarrhoeas, shortness of breath etc.),
- signs of suffering: apathy, nervousness, fear, etc.

The above would be signs of stress and would, therefore, indicate the possibility of the appearance of transportation fever or other diseases. Diseases like those referred to, together with several inflammatory diseases, were described years ago as conditions that caused stress in bovine animals (Robertson et al., 1958). If such signs were to appear as a consequence of transportation, they would be useful so as to decide on a more detailed inspection. Evidence exists for specific cases in the sense that the breach of welfare regulations can lead to *post-mortem* findings (Knock and Carroll, 2019) and many of the elements referred to above are related to such findings. Sometimes, as is the case with prolapses, these processes can have an unclear etiologic cause (Drost, 2007) and these animals need a more detailed inspection for an opinion to be issued. The evidence of the existence of irritations and desiccation of the mucosae exposed highlight the lack of suitability for transportation in the event of prolapses, as well as its nature as a stress generator, as commented before (Drost, 2007). It could also be noted that animals presenting pain while moving, with open wounds or physical weakness, pain, fear, etc., must not be transported, as this will increase the stress in the animal that is being transported, a fact that, as stated, is related to infectious processes in animals.

The aspects mentioned are signs of a potential risk of presence of other pathological processes that lead to seizures and have a great importance for public health. Likewise, specifically, there are signs from those already considered in this section that are directly related to specific processes such as tuberculosis or salmonellosis. In the case of tuberculosis, when such a process is at a late stage, a progressive weakness will be perceived in the animals (Kuria, 2019). In the case of salmonellosis, the sign that could provide a warning on the presence of such a process are diarrhoeas, as it is a gastrointestinal process (EFSA, 2013a).

Other elements of welfare to be considered specifically would be porcine animals with necrosis on their tails, and animals with objective deficiencies with regard to welfare conditions, such as overcrowding. With regard to animals presenting tail necrosis during the handling for the *post-mortem* infection, this aspect has been recently studied by Vom Brocke et al. (2019). These authors found associations between this process and many other *post-mortem* findings such as abscesses, pulmonary processes, arthritis, and other inflammations and/or alterations that were observable *post-mortem*, even cachexia. In this study, a remarkable number is highlighted of finishing pigs that may present these processes caused by bites and which may be a significant loss and, doubtlessly, an element to be taken into account in case a risk assessment is performed vis-à-vis the performance of supplementary palpations and incisions during the *post-mortem* inspection. With regard to crowding, this phenomenon has been declared a cause for stress in animals. This crowding or overload in the number of animals assigned according to the surface has been related to stress and bad handling (Loerch and Fluharty, 1999) (EFSA, 2012, 2020) and, therefore, to the possibility of the appearance of the processes referred to above.

On another note, the presence of animals with cachexia is also suggested in the Orientation Guidebook as a criterion to perform additional palpations and incisions, thus considering them as animals with a higher risk. Notwithstanding, cachexia was a criterion of specific full seizure according to the old Royal Decree 147/1993 (BOE, 1993). Cachexia or emaciation (Kautto et al., 2017) is a pathologic loss of weight characterised by an important loss of muscle and lack of fat or the presence of gelatinous fat in several areas and, both in persons and in animals, it is an unequivocal symptom of several serious diseases lasting in time such as cancer, serious chronic infectious diseases, or metabolic diseases. Based on the above, there would be no room for a discussion on complementary palpations and incisions, as a specific diagnosis as is the diagnosis of cachexia would already have been reached, the criterion for cachexia (BOE, 1993) or emaciation (EU, 2019) being the full seizure. In this sense, and as envisaged in Regulation (EC) No. 854/2004 (EU, 2004b), it must be highlighted that, as an objective datum, the presence of “malnourished animals” may be a more precise term, as the terms cachexia or emaciation are directly related to the pathologic process that is behind such pathologic loss of weight and, evidently, a diagnosis should be provided that is consistent with such a loss.

6. Aspects related to the conclusions to the *post-mortem* inspection

As indicated in the Orientation Guidebook, if, by reason of the *post-mortem* inspection, the decision is reached to perform an inspection with additional incisions and palpations in individual animals, in

a portion of a lot, or in a full lot, adequate measures would need to be adopted so that the inspection is performed separately regarding the space and/or time of the line of slaughtering of the other animals, further maximising the hygienic measures and subsequently disinfecting the tools and, to the extent possible, the facilities and the equipment. If, by reason of the design of the slaughterhouse this could not be accomplished, the *post-mortem* inspection could be carried out in the same line of slaughtering, provided that the economic operator applies the conditions necessary to do so: a decrease in the speed of the chain of slaughtering, the preservation of a distance between the different consignments and/or between the previous and the subsequent animal and a maximisation of the hygienic measures during the handling, with the subsequent cleaning and disinfecting of the facilities, the equipment and the tools, pursuant to the requirements deemed suitable by the Official Veterinary Services, so as to maintain the hygiene of the meats at all times.

If we are to consider that, in most cases, the decision on the fitness or unfitness of the meats for human consumption is carried out immediately after the *post-mortem* inspection, this section would be less useful at the time to assess the risk. This is because the assessment of the risk must be a tool that serves to plan actions according to Section 24 of the Commission Implementing Regulation (EU) 2019/627 (EU, 2019). The improvement in the *post-mortem* inspection based on the risk assessment is determined in itself by the consideration of the visual inspection as the main element of such an inspection (Hamilton et al., 2002) (Pointon et al., 2018). Also Sánchez et al. (2018) highlight that prior knowledge on the processes that need to be taken into account the most in risk assessment is one of the key elements for inspection improvement. Indeed, the very organisation of the inspection is one of the key aspects exposed in this document, and the fact of resorting to, i.e., food chain information to catalogue the relevant animal or animals pursuant to the risk assessment performed after comparing this information is an essential issue that allows, for instance, to establish the order of slaughtering of slaughter animals based on their greater or lesser risk so as to avoid the contamination of the facilities etc. Notwithstanding, the fact that Article 24 of the referred Regulation envisages the conclusions of the *post-mortem* inspection carried out pursuant to Articles 12 to 24 as an element to be taken into account will mean that a list of items needs to be available corresponding to this section for which additional palpation and incision procedures of the areas affected would need to be performed so as to serve as a guidebook for the inspectors. In practice, these additional palpations and incisions come after the rest of the inspection, that is to say, when an inspector or veterinary assistant is observing, for example, an abscess on the head of a bovine animal that is more than 8 months old, they will need to consecutively examine the retropharyngeal ganglions, as the presence of an abscess on such a region can lead to an additional risk in the carcass and must therefore be investigated. Notwithstanding, this operation is something consecutive as, for example, it is not very practical to establish a specific level of risk planned for such a carcass before a more detailed inspection has been carried out. This is something mainly formalistic but it needs to be recorded, as the following list includes causes for declaring the carcasses of slaughter animals as "unfit". Notwithstanding, a complete and detailed inspection is needed in most cases to calculate the level of involvement of the carcass and the spoils in a precise manner. There are also some causes in the list that already request for prior additional procedures. For example, in order

to detect an anomaly of consistency, a palpation needs to have already been performed. However, considering that the fact of performing palpations additional to the visual inspection is already an additional procedure in itself, this would mean that the performance of such a thorough inspection had already been considered. Such causes would be:

- Abscesses, purulent processes, proliferative processes, tumours.
- Deficient exsanguination.
- Haemorrhagic lesions on the skin, the mucosae or the viscera.
- Organoleptic anomalies, physiopathological anomalies, or anomalies of consistency.
- Febrile carcasses, anaemic meats, icteric meats, septicemic meats and toxemic meats.
- Lymphadenitis
- Peritonitis o pleuritis con adherencias.
- Arthritis or polyarthritis.
- Suspicion of presence of illegal drug residues or treatments.
- Lesions consistent with tuberculosis.
- Detection of foreign bodies.
- Cachexia or scarce meat conformation.
- Breeding animals and cull animals.

Already Royal Decree 147/1993 considered meats presenting any of the characteristics above as unfit (BOE, 1993). Therefore, the above are classical causes for full unfitness or partial unfitness depending on the extent of the process and other related aspects. It is necessary to complete such an opinion with a detailed inspection and even with laboratory determinations. Notwithstanding, Regulation (EC) No. 854/2004 (EU, 2004b) in force until 2017, included less criteria explicitly identical to the criteria proposed, although, in practice, they come to include basically the same cases as, for instance, almost all of the elements included in the list above can be included under the concept of physiopathological alterations included in the referred Regulation. All these elements can also be found both in the classical literature as generators of unfit meats (Moreno, 2003) and in the most recent literature (García-Díez and Coelho, 2014) (Sánchez et al., 2018) (Tabaran et al., 2018) (Chinonyerem and Kalu, 2019) (Guardone et al., 2020). Thus, in all the cases above, a more detailed inspection with additional palpations and incisions applies.

Conclusions of the Scientific Committee

The risk assessment regarding animals that have been or are going to be slaughtered is stated in Article 24 of Regulation (EU) 2019/627, which envisages the practical modalities in the inspection of meats of slaughter animals. Such risk assessment is carried out pursuant to five aspects:

1. Aspects rising out of the reviews and the analyses of the food chain information and the health documentation supporting the transportation of the animals to the slaughterhouse or of other official databases.
2. Aspects related to the conclusions to the *ante-mortem* inspection.
3. Aspects resulting from the verifications of compliance with animal welfare rules.

4. Cases arising out of the findings of the *post-mortem* inspection.
5. Other epidemiologic data or otherwise on the holding of provenance of the animals.

The Spanish Agency for Food Safety and Nutrition (AESAN), in cooperation with the autonomous regions, has created an "Orientation Guidebook on cases where additional procedures to the routinary *post-mortem* inspection at slaughterhouses should be carried out". In this guidebook, a series of subsections have been suggested by consensus that would be a sign of animals with an increased risk and for which a *post-mortem* inspection with additional palpations and incisions would be carried out subject to such a consideration as a greater risk.

Below, the conclusions are introduced of the Scientific Committee of AESAN on the signs that indicate the need to apply the additional palpation and incision procedures established in the referred Guidebook.

The subsections appearing in the Guidebook and considered in this report with regard to the food chain information and other epidemiologic aspects or data on the holding of provenance are:

- Food chain information with deficiencies or doubts about its validity or reliability.
- Deficiencies with regard to the identification of the animal.
- Animals treated with veterinary drugs.
- Animals coming from holdings where diagnoses have been performed within the last 12 months of diseases that may affect the innocuousness of the meat.
- Positive results regarding zoonosis control within the last 6 months.
- Notices by slaughterhouses relevant for other animals in the holding from a sanitary point of view.
- Animals from holdings with an epidemiologic history within the last 12 months as a result of infectious or parasitic pathologies relevant for Animal Health or for Public Health (tuberculosis, hydatids...).
- Animals under an extensive regimen in contact with wildlife.
- Holdings subject to restrictions by the Competent Authority for a risk of entry of diseases in other regions, communities, or countries.
- Animals coming from holdings where residues or polluting elements have been found in the controls carried out within the last 6 months.
- Positive animals within the frame of the national program of eradication of bovine tuberculosis.

The Scientific Committee considers the subsections referred to as sufficient from a practical perspective and based on the fact that, as stated in Heading 2 of this report, this list is not intended to be a comprehensive list of all the cases that can mean an increased risk.

Arising out of the *ante-mortem* inspection:

- Animals with an increased risk as a result of presenting a high temperature, hypothermia, visible lesions such as abscesses, injuries, inflammatory processes such as arthritis, etc. which, according to the inspectors' criteria, request for a more detailed *post-mortem* inspection.
- Animals presenting a stunted growth or whose fattening phase is not completed.

- Animals with a suspicious conformation based on the gender, the race.
- Animals with a probability of suffering from the diseases for which Regulation (EU) 2016/429 establishes animal health standards.
- Animals that underwent emergency slaughter according to Regulation (EC) No. 853/2004.

The Scientific Committee considers the subsections referred to as sufficient from a practical perspective and based on the fact that, as stated in Heading 2 of this report, this list is not intended to be a comprehensive list of all the cases that can mean an increased risk.

Respect to animal welfare:

- Animals that suffer from stress, unfit for transportation as a result of the presence of prolapses, animals that are incapable of moving on their own without pain or unaided, animals with injuries, or physically weak.
- Animals presenting other signs that make them unfit for transportation, vomits, diarrhoeas, shortness of breath...
- Animals with cachexia.
- Animals with tail necrosis.
- Animals with signs of suffering, apathic animals, scared animals, etc.
- Animals experiencing overcrowding, with injuries.

The Scientific Committee also considers the subsections referred to as sufficient from a practical perspective and based on the fact that, as stated in Heading 2 of this report, this list is not intended to be a comprehensive list of all the cases that can mean an increased risk. Notwithstanding, the Committee suggests that the term "with cachexia" be substituted with the term malnourished animals or animals with signs of malnourishment.

With regard to findings detected during the *post-mortem* inspection:

- Animals presenting abscesses, purulent processes and, in general, lesions that need to be examined.
- Animals with deficient exsanguination, with haemorrhagic lesions, petechias, contusions, purpura...
- Meats with organoleptic anomalies, physiopathological anomalies, or anomalies of consistency, suspected to be febrile carcasses, anaemic meats, icteric meats, septicemic meats, and toxemic meats.
- Animals presenting lymphadenitis.
- Animals with peritonitis or pleuritis with adhesions.
- Animals with arthritis or polyarthritis.
- Meats suspected of containing residues of illegal drugs or treatments.
- Lesions consistent with tuberculosis.
- Presence of foreign bodies.
- Animals with cachexia, with scarce meat conformation.
- Breeding animals and cull animals.

The Committee considers the subsections referred to as sufficient from a practical perspective and based on the fact that, as stated in Section 2 of this report, this list is not intended to be a comprehensive list of all the cases that can mean an increased risk. It is advisable, notwithstanding, for a more extended use of the terms “suspicion” or “suspected” in order to describe certain processes such as, animals with anomalies or with a suspicion of organoleptic, physiopathological, or consistency anomalies... Likewise, the term “with cachexia” can be substituted with “malnourished” or “suspected to suffer from cachexia”.

All the processes listed have been included in the scientific literature and/or applicable regulations as processes related to diseases transmissible to people or to animals, such diseases being related to the production of meats that are fully or partially unfit, that is to say, meats with an increased risk and, therefore, liable for inclusion for the performance of additional palpations and incisions under Regulation (EU) 2019/627. We must also stress that, even if these are formalistic aspects, there are some inaccuracies, like the fact of using certain elements that would be used in themselves to declare such animals as unfit, as is the case with cachexia. Likewise, it must be highlighted that the risk assessment needs to be an element that allows for a “planned” decision-making regarding the type of inspection that will be carried out. Notwithstanding, the items included in the conclusions of the *post-mortem* inspection for the performance of additional palpations and incisions entail an action consecutive to the *post-mortem* inspection itself. Therefore, they are regarded as less useful because it is more difficult to plan actions for this type of cases.

References

- Blaha, T., Meemken, D., Dickhaus, C.P. and Klein, G. (2007). Vorschläge zur Gestaltung der Lebensmittelketteninformationen für die Umsetzung der risikoorientierten Schlacht tier- und Fleischuntersuchung [Proposals for designing the food chain information for the implementation of the risk-oriented ante- and *post-mortem* meat inspection]. *DTW. Deutsche Tierärztliche Wochenschrift*, 114 (8), pp: 309-316.
- Blancou, J., Chomel, B.B., Belotto, A. and Meslin, F.X. (2005). Emerging or re-emerging bacterial zoonoses: factors of emergence, surveillance and control. *Veterinary Research*, 36 (3), pp: 507-522.
- BOE (1993). Ministerio de Relaciones con las Cortes y de la Secretaría del Gobierno. Real Decreto 147/1993, de 29 de enero, por el que se establece las condiciones sanitarias de producción y comercialización de carnes frescas. BOE N° 61 de 12 de marzo de 1993, pp: 7770-7792.
- BOE (1998). Real Decreto 1980/1998, de 18 de septiembre, por el que se establece un sistema de identificación y registro de los animales de la especie bovina. BOE N° 239 de 6 de octubre de 1998, pp: 33212-33220.
- BOE (2009). Ministerio de la Presidencia. Real Decreto 361/2009, de 20 de marzo, por el que se regula la información sobre la cadena alimentaria que debe acompañar a los animales destinados a sacrificio. BOE N° 75 de 28 marzo de 2009, pp: 29651-29660.
- Bosch, J., Rodríguez, A., Iglesias, I., Muñoz, M.J., Jurado, C., Sánchez-Vizcaíno, J.M. and de la Torre, A. (2017). Update on the risk of introduction of African Swine Fever by wild boar into disease-free European Union Countries. *Transboundary and Emerging Diseases*, 64 (5), pp: 1424-1432.
- Broughan, J.M., Downs, S.H., Crawshaw, T.R., Upton, P.A., Brewer, J. and Clifton-Hadley, R.S. (2013). *Mycobacterium bovis* infections in domesticated non-bovine mammalian species. Part 1: Review of epidemiology and laboratory submissions in Great Britain 2004-2010. *The Veterinary Journal*, 198 (2), pp: 339-345.

- Cantas, L. and Suer, K. (2014). Review: the important bacterial zoonoses in "One Health" concept. *Frontiers in Public Health*, 2 (144), pp: 144.
- Chinonyerem, U. and Kalu, E. (2019). Prevalence of diseases/conditions that lead to condemnation of bovine organs/carcass at postmortem examination. *Global Veterinaria*, 21 (4), pp: 225-231.
- Cooper, K.M., Whyte, M., Danaher, M. and Kennedy, D.G. (2012). Emergency slaughter of casualty cattle increases the prevalence of anthelmintic drug residues in muscle. *Food Additives & Contaminants: Part A*, 29 (8), pp: 1263-1271.
- Cutler, S.J., Fooks, A.R. and van der Poel, W.H.M. (2010). Public Health Threat of New, Reemerging and Neglected Zoonoses in the industrialized World. *Emerging Infectious Diseases*, 16 (1), pp: 1-7.
- De Vries, A. and Marcondes, M.I. (2020). Review: Overview of factors affecting productive lifespan of dairy cows. *Animal*, 14 (supplement 1), pp: s155-s164.
- Doherr, M.G., Heim, D., Fatzer, R., Cohen, C.H., Vandevelde, M. and Zurbriggen, A. (2001). Targeted screening of high-risk cattle populations for BSE to augment mandatory reporting of clinical suspects. *Preventive Veterinary Medicine*, 51 (1-2), pp: 3-16.
- Drost, M. (2007). Complications during gestation in the cow. *Theriogenology*, 68 (3), pp: 487-491.
- Duff, G.C. and Galyean, M.L. (2007). Recent advances in management of highly stressed, newly received feedlot cattle. *Journal of Animal Science*, 85 (3), pp: 823-840.
- Dupuy, C., Demont, P., Ducrot, Ch., Calavas, D. and Gay, E. (2014). Factors associated with offal, partial and whole carcass condemnation in ten French cattle slaughterhouses. *Meat Science*, 97 (2), pp: 262-269.
- Earley, B., Buckham, K. and Gupta, S. (2017). Invited review: Relationship between cattle transport, immunity and respiratory disease. *Animal*, 11 (3), pp: 486-492.
- EFSA (2011). European Food Safety Authority. Scientific Opinion on the public health hazards to be covered by inspection of meat (Swine). *EFSA Journal*, 9 (10), pp: 2351.
- EFSA (2012). European Food Safety Authority. Scientific Opinion on the welfare of cattle kept for beef production and the welfare in intensive calf farming systems. *EFSA Journal*, 10 (5), pp: 2669.
- EFSA (2013a). European Food Safety Authority. Scientific Opinion on the public health hazards to be covered by meat inspection of meat (bovine animals). *EFSA Journal*, 11 (6), pp: 3266.
- EFSA (2013b). European Food Safety Authority. Scientific Opinion on the public health hazards to be covered by inspection of meat from sheep and goats. *EFSA Journal*, 11 (6), pp: 3265.
- EFSA (2013c). European Food Safety Authority. Scientific Opinion on the public health hazards to be covered by inspection of meat (solipeds). *EFSA Journal*, 11 (6), pp: 3263.
- EFSA (2013d). European Food Safety Authority. Scientific Opinion on the public health hazards to be covered by inspection of meat from farmed game. *EFSA Journal*, 11 (6), pp: 3264.
- EFSA (2020). European Food Safety Authority. Scientific Opinion on welfare of cattle at slaughter. *EFSA Journal*, 18 (11), pp: 6275.
- Ellerbroek, L. (2007). Risk based meat hygiene-examples on food chain information and visual meat inspection. *DTW. Deutsche Tierärztliche Wochenschrift*, 114 (8), pp: 299-304.
- EU (2000). Commission Decision 2000/764/CE of 29 November 2000 on the testing of bovine animals for the presence of bovine spongiform encephalopathy and amending Decision 98/272/EC on epidemio-surveillance for transmissible spongiform encephalopathies. OJ L 305 of 6 December 2000, pp: 35-38.
- EU (2004a). Regulation (EC) No. 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for on the hygiene of foodstuffs. OJ L 139 of 30 April 2004, pp: 55-205.
- EU (2004b). Reglamento (CE) No. 854/2004 of the Parliament and the Council of 29 April 2004 laying down specific

- rules for the organisation of official controls on products of animal origin intended for human consumption. OJ L 139 of 30 April 2004, pp: 139- 206.
- EU (2014). Commission Regulation (EU) No. 218/2014 of 7 March 2014 amending Annexes to Regulations (EC) No. 853/2004 and (EC) No. 854/2004 of the European Parliament and of the Council and Commission Regulation (EC) No. 2074/2005 Text with EEA relevance. OJ L 69 of 8 March 2014, pp: 95-98.
- EU (2016). Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law'). OJ L 84 of 31 March 2016, pp: 84-208.
- EU (2019). Commission Implementing Regulation (EU) 2019/627 of 15 March 2019 laying down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption in accordance with Regulation (EU) 2017/625 of the European Parliament and of the Council and amending Commission Regulation (EC) No. 2074/2005 as regards official controls. OJ L 131 of 17 May 2019, pp: 51-100.
- Felin, E., Outi, H., Mari, H., Elias, J. and Fredriksson-Ahomaa, M. (2019). Assessment of the feasibility of serological monitoring and on-farm information about health status for the future meat inspection of fattening pigs. *Preventive Veterinary Medicine*, 162 (1), pp: 76-82.
- Fosse, J., Seegers, H. and Magras, C. (2008). Foodborne zoonoses due to meat: a quantitative approach for a comparative risk assessment applied to pig slaughtering in Europe. *Veterinary Research*, 39 (1), pp: 1.
- FSIS (2020). Food Safety and Inspection Service. Unites States Department of Agriculture. Ante-Mortem Livestock Inspection -Revision 3. FSIS Directive 6100.1. Available at: <https://www.fsis.usda.gov/policy/fsis-directives/6100.1> [accessed: 9-02-21].
- Gallagher, M.J., Higgins, I.M., Clegg, T.A., Williams, D.H. and More, S.J. (2013). Comparison of bovine tuberculosis recurrence in Irish herds between 1998 and 2008. *Preventive Veterinary Medicine*, 111 (3-4), pp: 237-244.
- García-Díez, J. and Coelho, A.C. (2014). Causes and factors related to pig carcass condemnation. *Veterinari Medicina*, 59 (4), pp: 194-201.
- Gomes-Neves, E., Müller, A., Correia, A., Capas-Peneda, S., Carvalho, M., Vieira, S. and Cardoso, M.F. (2018). Food Chain Information: Data Quality and Usefulness in Meat Inspection in Portugal. *Journal of Food Protection*, 81 (11), pp: 1890-1896.
- Grubman, M.J. and Baxt, B. (2004). Foot-and-Mouth Disease. *Clinical Microbiology Reviews*, 17 (2), pp: 465-493.
- Guardone, L., Vitali, A., Fratini, F., Pardini, S., Cenci, B.T., Nucera, D. and Armani, A. (2020). A retrospective study after 10 years (2010-2019) of meat inspection activity in a domestic swine abattoir in Tuscany: The slaughterhouse as an Epidemiological Observatory. *Animals*, 10 (10), pp: 1907.
- Haasnoot, W., Stouten, P., Cazemier, G., Lommen, A., Nouws, J.F.M. and Keukens, H.J. (1999). Immunochemical detection of aminoglycosides in milk and kidney. *Analyst*, 124, pp: 301-305.
- Hamilton, D.R., Gallas, P., Lyall, L., Lester, S., McOrist, S., Hathaway, S.C. and Pointon, A.M. (2002). Risk-based evaluation of postmortem inspection procedures for pigs in Australia. *The Veterinary Record*, 151 (4), pp: 110-116.
- Heinonen, M., Bergman, P., Fredriksson-Ahomaa, M., Virtala, A.M., Munsterhjelm, C., Valros, A., Oliviero, C., Peltoniemi, O. and Hälli, O. (2018). Sow mortality is associated with meat inspection findings. *Livestock Science*, 208 (2), pp: 90-95.
- Kautto, A.H., Vagsholm, I. and Niskanen, R. (2017). Meat inspection of reindeer -a rich source of data for monitoring food safety and animal and environmental health in Sweden. *Infection Ecology & Epidemiology*, 7 (1), pp: 1340695.
- Knock, M. and Carroll, G.A. (2019). The potential of Post-Mortem Carcass Assessments in Reflecting the Welfare of Beef and Dairy Cattle. *Animals*, 9 (11), pp: 959.

- Krauss, H., Weber, A., Appel, M., Enders, B., Isenberg, H., Schiefer, H.G., Slenczka, W., Graevenitz, A.V. and Zahner, H. (2003). Parasitic Zoonoses. In book: *Zoonoses: Infectious diseases transmissible from animals to humans*. 3^a Ed. Washington D.C. ASM Press, pp: 334-343.
- Kumar, H., Bhardwaj, K., Kaur, T., Nepovimova, E., Kuča, K., Kumar, V., Bhatia, S.K., Dhanjal, D.S., Chopra, C., Singh, R., Guleria, S., Bhalla, T.C., Verma, R. and Kumar, D. (2020). Detection of Bacterial Pathogens and Antibiotic Residues in Chicken Meat: A Review. *Foods*, 9 (10), pp: 1504.
- Kuria, J.K.N. (2019). Disease Caused by Bacteria in cattle: Tuberculosis. In book: *Bacterial cattle diseases*. Intechopen.
- Laranjo-González, M., Devleeschauwer, B., Gabriël, S., Dorny, P. and Allepuz, A. (2016). Epidemiology, impact and control of bovine cysticercosis in Europe: a systematic review. *Parasites & Vectors*, 9 (1), pp: 81.
- Loerch, S.C. and Fluharty, F.L. (1999). Physiological changes and digestive capabilities of newly received feedlot cattle. *Journal of Animal Science*, 77 (5), pp: 1113-1119.
- Lupo, C., Le Bouquin, S., Balaine, L., Michel, V., Péraste, J., Petetin, I., Colin, P., Jouffe, L. and Chauvin, C. (2013). Bayesian network as an aid for Food Chain Information use of meat inspection. *Preventive Veterinary Medicine*, 109 (1-2), pp: 25-36.
- Martínez, M. (2020). Diagnóstico diferencial de tumores en lesiones procedentes de matadero. Trabajo Fin de Grado de Veterinaria. Universidad de León.
- Mellor, P.S. and Hamblin, Ch. (2004). African horse sickness. *Veterinary Research*, 35 (4), pp: 445-466.
- Moennig, V., Floegel-Niesmann, G. and Greiser-Wilke, I. (2003). Clinical Signs and Epidemiology of Classical Swine Fever: A Review of New Knowledge. *The Veterinary Journal*, 165 (1), pp: 11-20.
- Moreno, B. (1991). In book: *Higiene e Inspección de Carnes Vol I*. Díaz de Santos (Eds.). Madrid, España. ISBN: 9788479787646.
- Moreno, B. (2003). In book: *Higiene e Inspección de Carnes Vol II*. Díaz de Santos (Eds.). Madrid, España. ISBN: 84-79-78-573-X.
- Moreno, B. (2006). In book: *Higiene e Inspección de Carnes Vol I*. Díaz de Santos, (Eds.). Madrid, España. ISBN: 9788479787646
- Mötus, K., Viltrop, A. and Emanuelson, U. (2018). Reasons and risk factors for beef calf and youngstock on-farm mortality in extensive cow-calf herds. *Animal*, 12 (9), pp: 1958-1966.
- Naranjo, V., Gortazar, C., Vicente, J. and de la Fuente, J. (2008). Evidence of the role of European wild boar as a reservoir of *Mycobacterium tuberculosis* complex (review). *Veterinary Microbiology*, 127 (1-2), pp: 1-9.
- Parra, A., Larrasa, J., García, A., Alonso, J.M. and Hermoso de Mendoza, J. (2005). Molecular epidemiology of bovine tuberculosis in wild animals in Spain: a first approach to risk factor analysis. *Veterinary Microbiology*, 110 (3-4), pp: 293-300.
- PNIR (2018). Ministerio de Agricultura, Pesca y Alimentación. Informe anual de resultados del Plan Nacional de Investigación de Residuos 2018. Available at: https://www.mapa.gob.es/es/ganaderia/temas/sanidad-animal-higiene-ganadera/informeanualpnir2018_tcm30-381379.pdf [accessed: 9-02-21].
- Pointon, A., Hamilton, D. and Kiermeier, A. (2018). Assessment of the post-mortem inspection of beef, sheep, goats and pigs in Australia: Approach and qualitative risk-based results. *Food Control*, 90 (4), pp: 222-232.
- Pollock, J.M. and Neill, S.D. (2002). *Mycobacterium bovis* infection and tuberculosis in cattle. *The Veterinary Journal*, 163 (2), pp: 115-127.
- Riess, L.E. and Hoelzer, K. (2020). Implementation of visual-only swine inspection in the European Union: Challenges, Opportunities, and Lessons Learned. *Journal of Food Protection*, 83 (11), pp: 1918-1928.
- Robertson, W.G., Mixner, J.P., Bailey, W.W. and Lennon JR, H.D. (1958). Effect of certain acute stress conditions on the plasma levels of 17-hydroxycorticosteroids and protein-bound iodine in dairy cattle. *Journal of Dairy Science*, 41 (2), pp: 302-305.

- Ruiz, A. (2017). Causas de decomiso en un matadero porcino industrial en el Norte de España. Trabajo Fin de Grado, Facultad de Veterinaria Lugo. Available at: https://minerva.usc.es/xmlui/bitstream/handle/10347/15847/TFG_VET_2017_Ruiz_causas%20de%20decomiso.pdf?sequence=1&isAllowed=y [accessed: 9-02-21].
- Sánchez, P., Pallarés, F.J., Gómez, M.A., Bernabé, A., Gómez, S. and Seva, J. (2018). Importance of the knowledge of pathological processes for risk-based inspection in pig slaughterhouses (Study of 2002 to 2016). *Asian-Australasian Journal of Animal Sciences*, 31 (11), pp: 1818-1827.
- Sánchez-Vizcaíno, J.M., Mur, L., Gomez-Villamandos, J.C. and Carrasco, L. (2015). An Update on the Epidemiology and Pathology of African Swine Fever. *Journal of Comparative Pathology*, 152 (1), pp: 9-21.
- Stärk, K.D.C., Alonso, S., Dadios, N., Dupuy, C., Ellerbroek, L., Georgiev, M., Hardstaff, J., Huneau-Salaün, A., Laugier, C., Mateus, A., Nigsch, A., Alfonso, A. and Lindberg, A. (2014). Strengths and weaknesses of meat inspection as a contribution to animal health and welfare surveillance. *Food Control*, 39, pp: 154-162.
- Tabaran, A., Dan, S.D., Reget, O., Tabaran, A.F. and Mihaiu, M. (2018). Slaughterhouse survey on the frequency of pathologies found in bovine post-mortem inspections. *Bulletin UASVM Veterinary Medicine*, 75 (2), pp: 251-255.
- Terato, K., Do, Ch.T., Cutler, D., Waritani, T. and Shionoya, H. (2014). Preventing intense false positive and negative reactions attributed to the principle of ELISA to re-investigate antibody studies in autoimmune diseases. *Journal of Immunological Methods*, 407, pp: 15-25.
- Vial, F., Schärer, S. and Reist, M. (2015). Risk factors for whole carcass condemnations in the swiss slaughter cattle population. *Plos One*, 10 (4), pp: e0122717.
- Vom Brocke, A.L., Karnholz, C., Madey-Rindermann, D., Gauly, M., Leeb, C., Winckler, C., Schrader, L. and Dippel, S. (2019). Tail lesions in fattening pigs: relationships with postmortem meat inspection and influence of a tail biting management tool. *Animal*, 13 (4), pp: 835-844.
- Welsh, D.M., Cunningham, R.T., Corbett, D.M., Girvin, R.M., McNair, J., Skuce, R.A., Bryson, D.G. and Pollock, J.M. (2005). Influence of pathological progression on the balance between cellular and humoral responses in bovine tuberculosis. *Immunology*, 114 (1), pp: 101-111.
- Windhaus, A., Meemken, D., Blaha, T. and Klein, G. (2007). Ergebnisse zur Bewertung von Lebensmittelketteninformationen als Entscheidungsgrundlage für die risikoorientierte Fleischuntersuchung [Results of the evaluation of food chain information for a risk-oriented meat inspection]. *DTW. Deutsche Tierärztliche Wochenschrift*, 114 (8), pp: 305-308.