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The food safety value of de-boning finishing pig carcasses with lesions indicative of prior septicaemia

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ABSTRACT

The primary purpose of meat inspection is to protect the public health by ensuring that no meat unfit for human consumption enters the market. EU Regulation 854/2004 specifies that lesions indicative of a generalised condition should result in the condemnation of the carcass. However, the correct procedure concerning carcasses with lesions indicative of a prior septicaemia is not specified. In Denmark, such carcasses are de-boned to avoid the presence of abscesses in the muscles. The aim of this study was to evaluate the food safety value of this specific use of de-boning. Retrospective data from 1 year, in the form of meat inspection lesion codes for all finishing pigs slaughtered, at the seven largest Danish abattoirs were obtained from the Danish Slaughterhouse Database. These data revealed some differences between abattoirs in the proportion of carcasses sent for de-boning (min: 0.14%; max: 0.29%; $P < 0.001$) and showed large differences in how often abscesses were found at de-boning (min 0.34%; max 24.14%; $P < 0.001$). Less than 1% of the carcasses were totally condemned after de-boning. Samples from 102 finishing pig carcasses sent for de-boning (due to lesions indicative of prior septicaemia) underwent bacteriological examination. Samples were taken from each carcass, including from abscesses and muscle. The presence of bacteria in the muscle samples was compared to that of similar samples collected from carcasses unconditionally approved in another study ($N = 60$). A total of 6% of the abscesses and 83% of the muscle samples from the carcasses sent for de-boning were sterile (or below detection level). The only potential foodborne pathogen identified was *Staphylococcus aureus,* which was found in 15 abscesses and one muscle sample from the 102 carcasses sent for de-boning and in one of the 60 control muscle samples ($P = 0.86$). Based on the bacteriological findings, the human health risk related to meat from de-boned carcasses and meat from unconditionally approved carcasses was assessed to be equally low. Therefore, de-boning was not considered to be a necessary part of the meat inspection procedure to ensure food safety. Instead, thorough inspection (requiring deep cuts into the predilection sites for the abscesses) in the rework area could replace de-boning. In addition, if overlooked in the rework area, such abscesses would probably be found during cutting, and dealt with at the abattoir. A strict and thorough handling of the carcasses in the rework area, along with extra focus during processing, should therefore be sufficient.

1. Introduction

The primary aim of meat inspection is to ensure food safety, so that no meat or meat products unfit for human consumption enter the market. In the European Union (EU), post mortem inspection is governed by the EC Regulation No 854/2004 (The Meat Inspection Regulation) and EU regulation 218/2014 amending annexes to the Meat Inspection Regulation (Anon., 2004, Anon., 2014a, Anon., 2014b).

In Denmark, meat inspection codes have been developed, as are described in the Danish Meat Inspection Circular. All findings observed on the carcass or in the organs are recorded in the Danish Slaughterhouse Database. The Meat Inspection Circular describes in detail how individual lesion codes should be judged, and what should happen with the carcass (Anon., 2011). In brief, the carcass, plucks, and intestines without abnormalities should be

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unconditionally approved. If abnormalities are observed at the slaughter line, a decision is made as to whether these can be purged immediately or if further investigation is necessary. In the latter case, the carcass, plucks and intestines are sent to the rework area, where a thorough examination takes place before a final judgment is made. If a local abnormality is found, this part should be discarded, while the rest of the carcass or plucks can be approved (i.e. local condemnation). Carcasses and plucks showing signs of a generalised disease, such as septicaemia should be totally condemned.

Septicaemia is blood poisoning, whereas pyaemia is a sub-group of septicaemia cases caused by pyogenic bacteria, such as *Staphylococcus aureus* and some *Streptococcus* species (Jensen, Leifsson, Nielsen, Agerholm, & Iburg, 2010). The bacteria enter the bloodstream through skin infections, usually initiated by tail bites or severe wounds. The bacteria can then spread with the blood or the lymph throughout the body and settle in various organs and tissues, initiating abscess formation (McGavin & Zachary, 2007). Embolic pneumonia and haematogenous osteomyelitis are two potential outcomes of a pyaemic infection and are characterised by abscess formation in the lungs and bones, respectively (Jensen et al., 2010).

Hence, the Meat Inspection Regulation specifies that generalised disease should result in condemnation. However, the Regulation does not specify in detail what is meant by generalised disease (Anon., 2004). Alban, Steenberg, Thune-Stephensen, Olsen, and Petersen (2011) recommended a discussion between EU Member States regarding a common agreement, in which specific lesions related to septicaemia should lead to total condemnation. In this context, the question is how to deal with chronic lesions indicative of a prior septicaemia – occurring months prior to slaughter.

In Denmark, a distinction is made between lesions which reflect an acute stage of a generalised infection, and those indicating a chronic stage. If a lesion reflects an acute stage of infection, the carcass is totally condemned, in line with the EU Regulation. In contrast, carcasses with chronic purulent lesions indicative of prior septicaemia (characterised by clearly encapsulated abscesses in bones or organs) are sent for de-boning, according to the Danish Meat Inspection Circular (Anon., 2011). The final destination of the carcass is dependent upon the outcome of the de-boning. The aim of de-boning is to ensure that abscesses, which might be present due to a prior septicaemia, and which have not been found in the rework area, are detected. During this procedure, muscles are separated from the bones, and bones, joints, and any lesions are discarded. If an acute stage of infection can be ruled out during de-boning, the meat is approved for consumption.

The de-boning procedure was introduced in March 1994 along with an updated version of the Danish Meat Inspection Circular. Prior to this, the detection of lesions indicative of a systemic infection – irrespective of being chronic or acute – resulted in total condemnation.

Meat inspection procedures should be re-evaluated regularly to ensure that they target the most relevant hazards, as the hazards and agricultural practices evolve and change over time. EFSA (2011) stated that traditional meat inspection does not enable the detection of microbiological foodborne hazards of current relevance, including *Salmonella* spp. and *Yersinia enterocolitica*. Therefore, EFSA suggest that meat inspection should have more focus on microbiology. In response, Meemken et al. (2014) have suggested using serological herd profiles among others for zoonoses in pigs by meat-juice multi-serology.

The detection of lesions does not necessarily reflect a food safety concern, as most microbial agents to cause diseases in pigs are non-zoonotic, or are considered to be occupational zoonotic hazards rather than being foodborne (EFSA, 2011). Additionally, in carcasses with lesions indicative of prior septicaemia, pathogenic bacteria may not be present in the edible tissue.

The EU Meat Inspection Regulation introduced the possibility to implement modifications to the traditional meat inspection procedures of finishing pigs from controlled housing, providing a risk assessment could confirm that the change would not jeopardise human health (Anon., 2004). This initiated a modernisation process in several countries such as Denmark and the United Kingdom (Hill et al., 2013; Tongue et al., 2013). In Denmark, risk assessments undertaken by The Danish Agriculture & Food Council, in collaboration with academic partners, have covered changes from traditional meat inspection to visual inspection. These risk assessments addressed the palpation and incision of the mandibular lymph node and routine opening of the heart (Alban et al., 2008), palpation of the intestinal lymph nodes (Alban, Steenberg, Petersen, & Jensen, 2010), palpation of lungs and liver and their associated lymph nodes (Pacheco, Kruse, Petersen, & Alban, 2013), and the human health risk relating to septicaemia in Danish finishing pigs, associated with a visual inspection of the lungs (Kruse, Larsen, Skou, & Alban, 2015). All risk assessments showed no increase in the risk to food safety, when visual inspection was carried out. These findings are supported by EFSA, who recommended that inspection of carcasses should be performed visually to avoid microbial cross-contamination, and that palpation and incisions should only be applied where there is suspicion of a problem (EFSA, 2011).

After year-long discussions between the EU Commission, the stakeholders, Member States and the EU Parliament, it was finally agreed that visual-only inspection should be required for inspecting swine in the EU – as stated in the EU regulation 218/2014, amending annexes to the Meat Inspection Regulation (Anon, 2014a). Although the new regulation came into force in June 2014, visual-only inspection has only been implemented to a limited extent, due to export requirements from countries outside the EU (Bækbo et al., 2015).

In Denmark, the effect of de-boning has been questioned, in relation to the modernisation process of meat inspection. De-boning is associated with a substantial workload and extra costs due to the handling and loss of value of the meat. Farmers are deducted 33% in payment for every carcass sent for de-boning (Anon., 2015). Data from the Danish Classification Control revealed that de-boning is associated with expenses of almost €3 million per year (data provided by Larsen (2014), personal communication). The primary purpose of de-boning is to maintain food safety, yet whether this can be seen as a crucial step, or whether the effort is reflected in the gain is arguable.

The aim of this study was therefore to evaluate the use of de-boning in the Danish meat inspection of carcasses, and to investigate whether this procedure is necessary to ensure food safety. In this context, the following questions were addressed regarding the carcasses of finishing pigs:

- How is de-boning used in Danish abattoirs?
- Is the meat from carcasses sent for de-boning fit for human consumption?
- Is de-boning necessary for food safety?
- If not, what alternative practices could replace de-boning?

2. Materials and methods

2.1. Retrospective data

Data from the seven largest Danish abattoirs were extracted from the Danish Slaughterhouse Database covering 1 year (July