The results presented in this study support the recommended sieve mesh size of 180 – 200 µm in a recently developed ISO/NEN standard, which is to be published before the end of 2015.

Conclusions

Based on our results, the 180-µm mesh size sieve remains the sieve of choice for the meat inspection at the slaughterhouse labs, according to the EU-RM, and a 400-µm mesh size sieve should only be used supplemental to, but not replacing the standard 180-µm sieve. With the current study, we provide a useful contribution for decision makers to discuss a further harmonisation of meat inspection requirements between trade blocks.

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Handling of chronic cases of pyaemia/osteomyelitis in finishing pigs in Denmark – is de-boning necessary to maintain food safety?

Bækbo, A.K.*(1), Petersen, J.V.(1), Larsen, M.H.(2), Alban, L.(1)

Abstract

Meat inspection is up for debate and one issue deals with how to handle chronic cases of pyaemia/osteomyelitis in finishing pigs. In Denmark, such carcasses are required to be de-boned to avoid presence of osteomyelitis not found in the rework area. Around 40,000 pigs (0.24%) are subjected to de-boning in Denmark per year, and the associated costs amount to approx. €3 million. The questions are: 1) is the meat from such pigs fit for human consumption? 2) Is de-boning necessary, or do the meat inspectors find what they should in the rework area? And 3) which alternative practices could replace de-boning? To address this, data covering 1 year were extracted from the Danish Slaughterhouse Database including information from the 7 largest Danish abattoirs. Registration schemes covering findings during de-boning and the result of de-boning (approved/condemned) were provided by the individual abattoirs. Additionally, a questionnaire survey was undertaken regarding the de-boning personals’ experience related to de-boning. Furthermore, samples from 102 pigs sent for de-boning at one slaughterhouse were collected. These samples included abscesses found in pigs at the rework area plus one muscle sample per pig. All samples underwent microbiological investigation. As a control group, microbiological results obtained from a similar study from carcasses unconditionally approved at meat inspection were included.

Staphylococcus aureus, which has the potential to cause human illness, was found in 15 abscesses and 1 muscle of the 102 pigs sent for de-boning. S. aureus was also found in 1 of the 60 control samples. The results were included in a risk assessment that revealed the same very low health risk related to consumption of meat from de-boned pigs as from fully accepted pigs. Abscesses were found at de-boning in a low proportion of the pigs, at different sites of the carcass, varying between abattoirs. The vast majority of pigs sent for de-boning were accepted after de-boning (99.7%). If routine de-boning is no longer required, then focus on a thorough inspection at the rework-area will most likely result in a higher probability of finding abscesses at that stage of inspection. Moreover, overlooked abscesses will be found during cutting. Therefore de-boning is not considered necessary and could be replaced by condemnation of the affected part(s) only.

Introduction

In Denmark, carcasses with lesions indicative of chronic pyaemia/osteomyelitis found during meat inspection are required to be de-boned (Anon., 2011). The aim of de-boning is to ensure detection of abscesses not found in the rework area. Depending on the outcome of the de-boning, the meat and organs can be accepted for human consumption, while all bones, joints and any parts with lesions are discarded. The de-boning procedure is associated with substantial workload and expenses, resulting in loss of value of the carcass. Farmers suffer...
a 33% reduction in the payment for every pig sent for de-boning (The Classification Control, 2015). Based on data from the Classification Control, total expenses amount to approx. €3 million (Larsen, 2014, personal communication).

The effect of de-boning has been questioned. The main purpose is to maintain food safety, but is de-boning a crucial step in achieving this? In this context the following questions were addressed:

- Is meat from finishing pigs sent for de-boning fit for human consumption?
- Is de-boning necessary or do the meat inspectors find what they should in the rework area?
- Which alternative practices could replace de-boning?

**Material and methods**

Data covering 1 year (July 2012 – June 2013) were extracted from the Danish Slaughterhouse Database involving the 7 largest Danish abattoirs. Supplementary information regarding the result of the de-boned pigs (approved /condemned) and findings during the de-boning were provided by the individual abattoirs, in the form of handwritten schemes, which were examined manually. Additionally, a questionnaire survey was undertaken regarding the de-boning personals’ experience with de-boning.

Furthermore, samples were collected at one abattoir (Plant A), from 102 finishing pigs sent for de-boning: One muscle sample, distal on the right foreleg, from each pig, as well as abscesses found in these pigs at the rework area. All samples underwent microbiological investigations according to the methodology described by the Danish Veterinary and Food Administration (2005). Bacteria found were identified using Matrix-Assisted Laser Desorption Ionization – Time of Flight Mass Spectrometry. *Staphylococcus aureus* isolates were tested by Polymerase Chain Reaction for the genes encoding enterotoxin production (*sea-see*), by use of the primers described in Becker et al. (1998). *S. aureus* isolates were also tested for the *mecA* gene encoding methicillin resistance by using the protocol described by Stegger et al. (2012). As a control group, microbiological results from a previous study, described in Kruse et al. (2015), from carcasses which were fully accepted at meat inspection were included. Chi-square-tests or Fisher’s exact test were conducted aiming at assessing associations between the microbiological findings. It was tested whether there was an association between findings of bacteria in general in the muscle and abscess samples within the 102 pigs sent for de-boning. A second analysis looked specifically on findings of *S. aureus*. The same was done for the association between muscle samples from pigs sent for de-boning and fully accepted carcasses.

Finally, the results were included in a risk assessment on human health risk associated with ingestion of meat from pigs sent for de-boning, compared to meat from fully accepted carcasses. The risk assessment guidelines described by the World Organization for Animal Health (OIE, 2010) was used in this work.

**Results**

During the study period of 1 year, 40,000 finishing pigs were de-boned corresponding to 0.24% of total number of slaughterings. The share of pigs sent for de-boning varied between the 7 abattoirs (min 0.15%; max 0.32%, P < 0.001) (see Table 1). Osteomyelitis was the most common diagnosis given to these pigs at all abattoirs except at Plant E, where pyaemia was the most common diagnosis. Tail bite infection was registered for a varying proportion of the pigs (min 14%; max 49%)

There were statistical significant differences between abattoirs in the proportion of pigs with abscesses found during de-boning (min 0.34%; max 24.14%; P < 0.001) and the proportion of totally condemned carcasses.
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<td>12.18</td>
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<td>Carcass condemned after de-boning (%)</td>
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Some abattoirs had a detailed registration of findings while Plant A did not register this at all. There were no common trends in where the registered abscesses were located in the carcasses. The ham accounted for the largest share of abscesses at Plant C and Plant B, and the midbody was the most common site at Plant E. According to the questionnaire, abscesses are found at de-boning every day at some abattoirs and weekly or monthly at other abattoirs. An explanation given by some of the de-boning personal was that these may have been overlooked in the rework-area due to business and a high tempo. Another explanation mentioned was that abscesses are hidden deeply in e.g. the ham and the comb. This was supported by reporting from another slaughterhouse which mentioned that the reason for not finding these abscesses at the rework-area was because the cuts in relation to the extended pyaemia inspection are not made sufficiently deep.

From the 102 pigs sent for de-boning, 83% of the muscle samples and 6% of the abscess samples were sterile. The bacteria found in the remaining samples consisted mainly of known pig pathogens and environmental bacteria. The only potential human pathogen found was Staphylococcus aureus, which was found in 15 (9%) abscess samples and 1 muscle sample (5%). None of these were MRSA. Three isolates were tested positive for genes encoding enterotoxins – the 1 from the muscle had the gene encoding enterotoxin A, and the 2 from abscesses were positive for genes encoding enterotoxin A and C, respectively.

The Chi-square-tests/Fisher’s exact test revealed no association between findings of bacteria in general in the muscles and abscesses within the 102 pigs investigated (P = 0.86). No association was found for the specific findings of S. aureus either (P = 1). Considering the association between finding bacteria in muscles from pigs sent for de-boning compared to muscles from fully accepted carcasses, it was found that the risk was 5 times larger in pigs sent for de-boning (P = 0.01). However, no difference in risk was found for the specific findings of S. aureus (P = 0.86).

S. aureus was considered the only human pathogen among the bacteria found in the 102 pigs sent for de-boning. The human health risk associated with meat from pigs sent for de-boning was considered negligible.

Moreover, there was no difference in risk related to meat from de-boned pigs and meat from unconditionally approved carcasses. For an extended version of the risk assessment, please refer to Baekbo (2014).

Discussion

The variation in the proportion of pigs sent for de-boning indicates differences in the use of de-boning at the abattoirs, because the pigs are the same. The variation in recording of lesions and diagnoses that leads to de-boning may be due to traditions and habits at the local plant. The same may be the case for the specific handling of chronic cases of pyaemia in the rework-area at the different abattoirs. On some abattoirs inspectors are capable of finding almost all abscesses at the rework-area, whereas this is not the case at other abattoirs. This suggests that presence of undiscovered abscesses could reflect an incomplete inspection and handling at the rework-area, maybe because of time pressure. In this context it was assessed that a strict, thorough pyaemia inspection, including precise cuts in the ham, comb, shoulder and tenderloin would be able to reduce the number of undiscovered abscesses at the rework area.

The risk assessment revealed no difference in human health risk related to meat from finishing pigs sent for de-boning and meat from fully accepted carcasses. De-boning of pigs with lesions indicative of chronic pyaemia does not seem to have a food safety value; abscesses are not considered a food safety issue, but a quality parameter, so de-boning could actually be considered a quality assurance procedure. Therefore handling of chronic cases of pyaemia should be done by the slaughterhouses and not by an official veterinary inspector as required by the current meat inspection circular (Anon., 2011).

If de-boning is no longer a legal requirement, extra attention should be paid to the chronic cases of pyaemia at the rework-area to minimize the risk of overlooking abscesses. However, if an abscess is not found at the rework area, it will be found during the further processing of the carcass including cutting and routine de-boning, where abscesses are regularly found. Calculations based on 1 year of data from Plant A showed that abscesses related to pyaemia only constitute 4.4 % of the total prevalence of abscesses in finishing pigs (data not shown). All Danish slaughterhouses already have procedures in place to handle abscesses found at cutting and de-boning. Therefore, the probability that a consumer would find an abscess in a meat cut is very low, regardless of which pig the meat originate from. If an abscess after all is present in a meat cut, this is not considered a food safety problem but an unappetizing event. It is unlikely that the consumer will consume an abscess but if eaten inattentively, the risk of a staphylococcal intoxication is linked, among other things, to temperature abuse similar to the risk from unconditionally approved carcasses.

Conclusion

A risk assessment, based among others on the bacterial findings in this study, revealed a negligible risk associated with meat from finishing pigs sent for de-boning compared to meat from pigs unconditionally approved. A strict and thorough pyaemia inspection at the rework-area should be sufficient in finding abscesses present in the carcasses. If abscesses are not found at this stage, they will be found during the further processing, i.e. during cutting and routine de-boning. In case an abscess is not found at the slaughterhouse, but by a consumer, this will not constitute a food safety problem, but an unappetizing event.

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Emerging infectious diseases (EID) can be defined as those which incidence is increasing following its first introduction into a new host population or in an existing one as a result of long-term changes in its underlying epidemiology [1]. This concept can also include those diseases linked to pathogens expanding into an area in which it was not previously reported, or due to infectious agents that changed significantly its clinico-pathological presentation [2].

During last 10 years, much emphasis has been focused on human EID caused by pathogens of animal origin. All these zoonotic threats and events have emphasized the need for a "One Health" approach, which was summarized in the so called 12 Manhattan principles [3]. The "One Health" approach integrates communication, collaboration and coordination between public health, animal health and other communities at multiple levels to prevent, detect and control emerging or re-emerging infectious diseases at the animal–human–environment interface [4].

The number of novel conditions in swine included under the concept of emerging and re-emerging diseases has increased importantly during last 20-30 years [5]. Most of them are infectious diseases; their transmissibility and maintenance into a population is favoured by a number of phenomena, including intensive rearing practices and globalized/ international trading. The objective of the present review is to discuss about new swine diseases or novel presentations of already known diseases, as well as newly recognized infections with a not well-defined pathogenic effect in pigs, with specific emphasis on zoonotic diseases.

Monofactorial and multifactorial pig diseases

Traditionally, veterinarians have dealt with overt diseases, with the main task of counteracting them and getting profitability of the production system represented by a farm or a group of farms. Moreover, several decades ago, the most important diseases affecting pigs were considered mostly “monofactorial”, in which the sole presence of the infectious agent was sufficient to trigger significant disease or production losses [6]. In swine, most of these infectious diseases, such as classical swine fever (CSF), Aujeszky’s disease (pseudorabies), foot-and-mouth disease or African swine fever (ASF), among others, have been controlled or are under control in many parts of the world by means of eradication programs (World Organization for Animal Health, OIE, www.oie.int). However, these diseases may appear sporadically in free-countries as a result of trading of life animals or animal products, or citizen travelling. This scenario of disease re-introduction is not unusual, and recent examples of emerging and re-emerging diseases would be ASF in Russia and Eastern Europe, and porcine epidemic diarrhoea (PED) in Europe and North-America.

There are a number of not so devastating infections compared to those considered as “monofactorial”,