Bacterial community analysis for investigating bacterial transfer from tonsils to the pig carcass

Tonsils in the oral cavity are an important source of contamination during pig slaughter, but have not received as much attention as faecal contamination. In the present study, ten pigs were sampled from tonsils, faeces and three different areas on each carcass. The samples were analysed by both culturing of Escherichia coli and Yersinia enterocolitica and by 16S rRNA gene sequencing to characterize the bacterial communities. Comparing culture data from deep tonsil tissue and tonsil surface showed similar numbers of E. coli but significantly higher numbers of Y. enterocolitica in the deep tissue samples. Microbiota analysis showed similar bacterial communities in the two sample types at phylum level, while comparison at genus level showed significant differences between the relative abundance of several genera in the two sample types. The finding of a significantly higher relative abundance of Yersinia in tonsil tissue compared to tonsil surface supported the culture analysis. The microbiota analysis also investigated characteristics of the bacterial community that could discriminate bacterial transfer from tonsils and faeces to the carcass during slaughter. The microbiota analyses demonstrated that Fusobacteria and Proteobacteria are the most abundant phyla in tonsils, while Firmicutes showed the highest relative abundance in faeces. The dominating phylum on carcasses was Proteobacteria. Besides Proteobacteria, the swabbing area on the forepart of the carcass, showed a higher relative abundance of Firmicutes and Fusobacteria compared to swabbing areas on the rear part and mid-section of the carcass. Principal coordinate analysis showed clear clustering of samples based on sample source (tonsils, faeces and carcass). Carcass swab samples from the forepart tended to cluster closer to the tonsil samples compared to carcass swab samples from the rear part and mid-section. Identification of the genera Fusobacterium, Moraxella, Actinobacillus and non-E. coli genera of the family Enterobacteriaceae in carcass swabs could indicate tonsil contamination, while faecal contamination would more likely include higher prevalence of bacteria belonging to the class of Clostridia. The present study supports that it is possible to identify bacterial groups that are indicative for either tonsil or faecal carcass contamination. The level and composition of Enterobacteriaceae on the carcasses did, however, indicate that other sources of meat contamination than tonsils and faeces may be important, such as the process environment.
Cross and co resistance among Danish porcine E. coli isolates
Cross and co-resistance to antimicrobials are presented for 765 Danish Escherichia coli isolates of porcine origin from 2009 to 2013. All isolates and data originate from the DANMAP surveillance but have not previously been used to describe the occurrence of cross and co-resistance. Data presented here clearly indicate the ability of low classified antimicrobials as ampicillin to uphold resistance to critical important antimicrobials for human treatment.

Growth potential of pathogens in reverse osmosis filtrated whey intended for water re-use in cheese production
Growth potential of pathogens in reverse osmosis filtrated whey intended for water re-use in cheese production

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Growth potential of pathogens in reverse osmosis filtrated whey intended for water re-use in cheese production

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Growth potential of pathogens in reverse osmosis filtrated whey intended for water re-use in cheese production
Growth potential of pathogens in reverse osmosis filtrated whey intended for water re-use in cheese production
Presence of extended-spectrum cephalosporin (ESC) resistance Escherichia coli in two Danish poultry slaughterhouses

General information
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Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report
year: 2018 › Research › peer-review

A risk modelling approach for setting microbiological limits using enterococci as indicator for growth potential of Salmonella in pork

Microbiological limits are widely used in food processing as an aid to reduce the exposure to hazardous microorganisms for the consumers. However, in pork, the prevalence and concentrations of Salmonella are generally low and microbiological limits are not considered an efficient tool to support hygiene interventions. The objective of the present study was to develop an approach which could make it possible to define potential risk-based microbiological limits for an indicator, enterococci, in order to evaluate the risk from potential growth of Salmonella. A positive correlation between the concentration of enterococci and the prevalence and concentration of Salmonella was shown for 6640 pork samples taken at Danish cutting plants and retail butchers. The samples were collected in five different studies in 2001, 2002, 2010, 2011 and 2013. The observations that both Salmonella and enterococci are carried in the intestinal tract, contaminate pork by the same mechanisms and share similar growth characteristics (lag phase and maximum specific growth rate) at temperatures around 5-10 °C, suggest a potential of enterococci to be used as an indicator of potential growth of Salmonella in pork. Elevated temperatures during processing will lead to growth of both enterococci and, if present, also Salmonella. By combining the correlation between enterococci and Salmonella with risk modelling, it is possible to predict the risk of salmonellosis based on the level of enterococci. The risk model used for this purpose includes the dose-response relationship for Salmonella and a reduction factor to account for preparation of the fresh pork. By use of the risk model, it was estimated that the majority of salmonellosis cases, caused by the consumption of pork in Denmark, is caused by the small fraction of pork products that has enterococci concentrations above 5. log. CFU/g. This illustrates that our approach can be used to evaluate the potential effect of different microbiological limits and therefore, the perspective of this novel approach is that it can be used for definition of a risk-based microbiological limit for enterococci. The limit for enterococci can then be used for development of a process hygiene criterion in cutting plants and retail butcher shops, with the purpose of reducing the risk of Salmonella for the consumer.

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Generic global regression models for growth prediction of Salmonella in ground pork and pork cuts

Introduction and Objectives
Models for the prediction of bacterial growth in fresh pork are primarily developed using two-step regression (i.e. primary models followed by secondary models). These models are also generally based on experiments in liquids or ground meat and neglect surface growth. It has been shown that one-step global regressions can result in more accurate models and that bacterial growth on intact surfaces can substantially differ from growth in liquid culture.

Material and Methods
We used a global-regression approach to develop predictive models for the growth of Salmonella for three pork matrices: on the surface of shoulder (neck) and hind part (ham), and in ground pork. We conducted five experimental trials and inoculated essentially sterile pork pieces with a Salmonella cocktail (n = 192). Inoculated meat was aerobically incubated at 4 °C, 7 °C, 12 °C, and 16 °C for 96 h. One part of obtained log-transformed cell counts was used for model development and another for model validation. The Ratkowsky square root model and the relative lag time (RLT) model were integrated into the logistic model with delay. Fitted parameter estimates were compared to investigate the effect of meat structure on bacterial growth and goodness-of-fit was evaluated by root mean squared errors (RMSE). We used the Acceptable Simulation Zone (ASZ) approach and cross-validation with model-independent data to investigate if generic predictive models could accurately describe microbial growth across all studied pork products and compared our models to already existing generic models.

Results
Our results indicated that the growth of Salmonella was affected by product characteristics such as pH and structure, but storage temperature was shown to be the only variable needed to predict growth independent of pH and structural differences. RMSE of 0.54 suggested acceptable goodness-of-fit for the Salmonella generic growth model. Model evaluations of the generic growth model showed that described growth responses on pork neck and in ground pork were highly accurate with 86 and 98% of all model independent observations within the ASZ, respectively. Although growth descriptions showed less accuracy in the case of pork ham, a fail-safe model could still be developed. Model evaluation also showed that our model performed better than generic existing models.

Conclusions
We suggested that generic model with fewer variables might provide a more suitable approach to bacterial growth modeling in fresh pork if pH and the type of pork product are unknown. Our study provides a “readyto-use” global regression model relevant for a wide range of time and temperature combinations and various fresh pork products. The model should be a useful tool to control growth of Salmonella in meat and set critical limits for temperature during production and storage of fresh pork.

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Contributors: Buschhardt, T., Hansen, T. B., Bahl, M. I., Schaffner, D. W., Aabo, S.
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Microbiota analysis to reveal temperature abuse of fresh pork

Violations of temperature regulations in the meat chain may affect meat safety. Methods are lacking to estimate whether meat has been subjected to temperature abuse. Exposure to too high temperatures may lead to systematic changes in the diverse bacterial communities of fresh meat. We investigated whether temperature induced changes in the community composition on fresh meat surfaces can reflect the temperature-history (combination of time and temperature). Sterile pieces of pork were inoculated with a carcass swab homogenate, to which Salmonella was added. Changes in the meat microbiota were monitored during aerobic chill-storage (4 °C and 7 °C) and temperature abuse (12 °C and 16 °C) for 96 hours, by culture-based methods and 16S rRNA gene sequencing. Bacterial genera that dominated during prolonged temperature abuse were Acinetobacter, Serratia and Pseudomonas, whereas chill-stored meat was dominated by Pseudomonas only. We also showed that the initial community affects subsequent changes during storage. The results suggest that principal coordinate analysis of beta diversity could be a useful tool to reveal temperature abused meat. Sequence data and culturing data revealed a strong positive association between growth of Escherichia coli and growth of Salmonella, which suggests that Escherichia coli can be used as indicator of temperature-history supporting growth of Salmonella on fresh pork surfaces.

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Microbiota analysis to reveal temperature abuse of fresh pork

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Transmission of extended-spectrum cephalosporin (ESC) resistance through the broiler production system in Denmark

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ABSTRACT BOOK
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Antibiotic Resistance in Escherichia coli from Pigs in Organic and Conventional Farming in Four European Countries
Organic pig production differs in many ways from conventional production of pigs, e.g., in antibiotic use, herd structure, feeding regimes, access to outdoor areas and space allowance per pig. This study investigated if these differences result in a lower occurrence of antibiotic resistance in organic slaughter pigs in Denmark, France, Italy and Sweden. Samples were taken from the colon content and/or faeces and minimum inhibitory concentrations (MIC) of ten antibiotics were determined in isolates of Escherichia coli. In addition, the proportion of tetracycline (TET) resistant E. coli in colon content and/or faeces from individual pigs was determined. In all four countries the percentage resistance to ampicillin, streptomycin, sulphonamides or trimethoprim was significantly lower in E. coli from organic pigs. In France and Italy, the percentage of isolates resistant to chloramphenicol, ciprofloxacin, nalidixic acid or gentamicin was also significantly lower in the E. coli from organic pigs. Resistance to cefotaxime, was not found in any country. The percentage of E. coli isolates resistant to TET as well as the proportion of TET-resistant E. coli was significantly lower in organic than in conventional pigs, except in Sweden where TET-resistance was equally low in both production types. There were also differences between countries within production type in the percentage resistance to individual antibiotics as well as the proportion of TET-resistant E. coli with lower median proportions in Sweden and Denmark compared to France and Italy. The study shows that in each of the four countries resistance in intestinal E. coli was less common in organic than in conventional pigs, but that there were also large differences in resistance between countries within each production type, indicating that both country- and production-specific factors influence the occurrence of resistance.

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A risk-based approach for evaluation of hygiene performance at pig slaughter

In Denmark, the pig slaughterhouses have a daily input of pigs infected and/or contaminated with Salmonella, and the slaughter hygiene has major influence on the level of Salmonella contamination on the meat leaving the slaughterhouse. However, the relationship between the effect of improved hygiene performance and the consequential reduction of human health risk has not been estimated so far. In this study, swab samples from 2702 pig carcasses were collected, originally for other purposes, from five large Danish slaughterhouses in a period from 2005 to 2007, covering all seasons of the year. The samples were analysed quantitatively for E. coli and semi-quantitatively for Salmonella. A positive association between the number of E. coli on carcasses and the prevalence of Salmonella positive carcasses was shown. For carcasses positive for Salmonella, a positive association was also shown between the number of E. coli and the number of Salmonella on the carcass. As no biological association has been reported between faecal shedding of E. coli and presence of Salmonella, the relationship was considered to be associated with the level of faecal contamination. The positive association between E. coli and Salmonella was used as basis for developing a quantitative risk assessment model for Salmonella, using the level E. coli as model input. The model output associated the hygiene performance with a relative risk estimate of human salmonellosis. The overall objective was to develop a decision support tool that can be used to support risk-based hygiene interventions in pig slaughterhouses.

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ConFerm - A tool to predict the reduction of pathogens during the production of fermented and matured sausages

Existing growth models and non-thermal survival models for Salmonella, Shiga-toxin producing Eschericia coli (STEC) and Listeria monocytogenes primarily focus on the static effect of a(w), sodium nitrite (NaNO2), pH and temperature. However, during the production of fermented sausages, the intrinsic factors and temperature change, and there is a need to develop models that can predict pathogen survival under dynamic conditions. The objective of this study was to develop a novel mathematical model for predicting survival of Salmonella, STEC and L. monocytogenes, taking into account the dynamics of the sausage environment during fermentation and maturation of fermented sausages. A total of 73 experiments were carried out in sausages containing different levels of NaCl in the water phase (WPS) (3.9-6.8%), NaNO2 (0-200 ppm) and pH(48h) (4.3-5.6). The minced meat was inoculated with approx. 10(6) cfu/g of a multi-strain cocktail of 3 strains of Salmonella (S. Dublin, S. Typhimurium, S. Derby), 3 strains of STEC (O26:H-, O111:H- and O157) and five L. monocytogenes strains isolated from different meat products and environment. The sausages were fermented at 24 degrees C for 48 h using three different commercially available starter cultures followed by maturation at 16 degrees C until a weight loss of between 15% and 35% was achieved. Enumeration of Salmonella, STEC and L. monocytogenes was
performed up to six times during fermentation and maturation, allowing for calculation of the logio reductions at each time point. The microbiological data, together with data for NaNO2 and changes in pH and WPS, were used to develop the “ConFerm” tool, which consists of three separate partial least squares regression (PLS) models for predicting the reduction of Salmonella, STEC and L. monocytogenes, respectively, as a function of weight loss, pH decrease, NaNO2 and WPS. The “ConFerm” tool was validated on a separate data set (n = 19). The Salmonella model had bias and accuracy factors of 1.02 and 1.15, the STEC model 1.04 and 1.24 and the L. monocytogenes model 0.99 and 1.27, respectively, indicating highly acceptable models. In conclusion, the models are applicable for predicting reduction of Salmonella, STEC and L. monocytogenes during the production of fermented sausages fermented at 24 degrees C and matured at 16 degrees C. The model has been made available to producers and other interested parties at http://dmripredict.dk (in English). (C) 2016 Elsevier Ltd. All rights reserved.

Enterococci as indicator of potential growth of Salmonella in fresh minced meat at retail
The present study had the purpose of demonstrating a positive correlation between enterococci and Salmonella in minced pork and beef. Data from 2001 to 2002 from retail minced pork and beef in Denmark were used and the association between concentration of enterococci and prevalence and concentration of Salmonella was examined. A total of 2187 and 2747 samples of minced pork and beef, respectively, were collected from butcher shops and supermarkets throughout the country. In pork, 2.1% of all samples were positive for Salmonella whereas 1.5% of beef samples were positive. Among samples with ≥100 CFU/g of enterococci, prevalence of Salmonella positive samples was 3.4%, which was significantly higher than 1.2% observed in minced meat with less than 100 CFU/g of enterococci (P <0.001). A positive association between occurrence of enterococci and presence of Salmonella in retail minced meat was supported as both prevalence and concentration of Salmonella in positive samples increased with increasing concentrations of enterococci in minced meat. From our data, we suggest that minced meat containing more than 500 enterococci per gram is suspected of having been exposed to temperatures allowing growth of Salmonella. This is to our knowledge the first report, which links presence of an indicator to potential growth of Salmonella.

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Evaluation of a cross contamination model describing transfer of Salmonella spp. and Listeria monocytogenes during grinding of pork and beef

A cross contamination model was challenged and evaluated applying a new approach. QMRA and Total Transfer Potential (TTP) were included. Transfer estimates were not applicable for unlike processing. The risk of disease may be reduced when using a stainless steel grinder. Well-sharpened knife, and room temperatures lower than 4°C can be beneficial.

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Organisations: National Food Institute, Research Group for Microbial Food Safety and Quality, Research group for Risk Benefit, University of Campinas, Universidade de Sao Paulo
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Fortsat indsats i handlingsplaner overfor campylobacter og salmonella - koordineret med VTEC i kvæg

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Contributors: Aabo, S.
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Original language: Danish
Growth potential of exponential- and stationary-phase Salmonella Typhimurium during sausage fermentation

Raw meat for sausage production can be contaminated with Salmonella. For technical reasons, meat is often frozen prior to mincing but it is unknown how growth of Salmonella in meat prior to freezing affects its growth potential during sausage fermentation. We investigated survival of exponential- and stationary-phase Salmonella Typhimurium (DT12 and DTU292) during freezing at −18 °C and their subsequent growth potential during 72 h sausage fermentation at 25 °C. After 0, 7 and >35 d of frozen storage, sausage batters were prepared with NaCl (3%) and NaNO2 (0, 100 ppm) and fermented with and without starter culture. With no starter culture, both strains grew in both growth phases. In general, a functional starter culture abolished S. Typhimurium growth independent of growth phase and we concluded that ensuring correct fermentation is important for sausage safety. However, despite efficient fermentation, sporadic growth of exponential-phase cells of S. Typhimurium was observed drawing attention to the handling and storage of sausage meat.

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Horizontal transfer of antimicrobial resistance in meat

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Robustness of a cross contamination model describing transfer of pathogens during grinding of meat
This study aimed to evaluate a cross contamination model for its capability of describing transfer of Salmonella spp. and L. monocytogenes during grinding of varying sizes and numbers of pieces of meats in two grinder systems. Data from 19 trials were collected. Three evaluation approaches were applied: i) Acceptable Simulation Zone method compared observed with simulated transfer, ii) each trial was fitted and parameters were integrated in a Quantitative Microbiological Risk Assessment model, iii) the Total Transfer Potential was calculated from fitted parameters. Risk estimates revealed that grinding was influenced by sharpness of grinder knife, specific grinder and grinding temperature.

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Variation in the effect of carcass decontamination impacts the risk for consumers
• The variation of decontamination has an effect on consumer risk reduction. • The effect of variation on risk is lower when mean log reduction is high. • The effect of variation on risk also depends on initial carcass contamination. • The effect of decontamination should be expressed as consumer risk reduction.

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Contributors: Ribeiro Duarte, A. S., Nauta, M., Aabo, S.
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16S rRNA gene sequencing as a tool to study microbial populations in foods and process environments: limitations and opportunities

Introduction: Methodological constraints during culturing and biochemical testing have left the true microbiological diversity of foods and process environments unexplored. Culture-independent molecular methods, such as 16S rRNA gene sequencing, may provide deeper insight into microbial communities and their role in food safety. During method optimization, we have identified several factors which distort the characterization of microbial populations, including DNA extraction methods, DNA polymerases, and most importantly the analyzed fragment of the 16S rRNA gene.
Methods: This study investigated microbial communities in meat and the meat process environment with special focus on the Enterobacteriaceae family as a subpopulation comprising enteropathogens including Salmonella. Samples were analyzed by a nested PCR approach combined with MiSeq® Illumina®16S DNA sequencing and standardized culture methods as cross reference.

Results: Taxonomic assignments and abundances of sequences in the total community and in the Enterobacteriaceae subpopulation were affected by the 16S rRNA gene variable region, DNA extraction methods, and polymerases chosen. However, community compositions were very reproducible when the same methods were used.

Conclusions: Altogether, we have shown that conclusions from population studies based on 16S rRNA gene sequencing need to be made with caution. Overcoming the constraints, we believe that population studies can give new research possibilities for e.g. interaction studies, identification and growth of indicator organisms, or source attribution.

A risk modelling approach for setting process hygiene criteria for Salmonella in pork cutting plants, based on enterococci.

Pork is known to be a key source of foodborne salmonellosis. Processing steps from slaughter to cutting and retail contribute to the Salmonella consumer exposure. In two extensive surveys comprising a total of 5,310 pork samples,
cuttings and minced meat were analysed semiquantitatively for Salmonella and quantitatively for the hygiene indicator enterococci. The samples were collected in 2001/2002 and 2010/2011 in Danish cutting plants, retail supermarkets and butcher shops. A positive correlation between prevalence of Salmonella and number of enterococci was shown (Hansen et al., 2013). As enterococci and Salmonella share a lower growth limit around 5°C, the positive correlation could imply that the meat had been exposed to temperatures above 5°C. Based on these findings, the objective of this study was to develop an approach for setting process hygiene criteria for predicting Salmonella risk in cutting plants from enterococci counts. The novel approach uses risk modelling to associate a relative consumer risk to different levels of enterococci in pork. The applied risk model was a modification of a model developed by Duarte et al. (submitted). The output is an estimate of the relative risk of acquiring salmonellosis associated to a given concentration of Salmonella. The relative risk of acquiring salmonellosis was then associated to the concentration of enterococci by using the observed positive correlation between Salmonella and enterococci as model input. From the applied model it was deduced how much the consumer risk can be reduced if enterococci is kept below a certain limit.

Evaluation of a cross contamination model describing transfer of salmonella spp. and listeria monocytogenes during grinding of pork and beef

Introduction: The cross contamination model (Møller et al. 2012) was evaluated to investigate its capability of describing transfer of Salmonella spp. and Listeria monocytogenes during grinding of pork and beef of varying sizes (50 – 324 g) and numbers of pieces to be ground (10 – 100), in two grinder systems. Methods: Data from 19 trials were collected. Three different evaluation approaches were applied: i) an Acceptable Simulation Zone (ASZ) method compared observed with simulated transfer from the proposed model, ii) each trial was fitted and its respective parameter estimates were integrated in a Quantitative Microbiological Risk Assessment (QMRA) model (Møller et al. 2015), and iii) the Total Transfer Potential (TTP) was calculated for each of the 20 fitted parameter estimates. Results: The ASZ showed that the Møller et al. (2012) model could only describe seven of the 19 trials to an acceptable extent. However, all transfer curves could be fitted to the model structure proposed by Møller et al. (2015). A positive correlation was found between QMRA risk estimates and TTP for the individual trials. Conclusions: Results indicated that transfer estimates were not applicable for unlike processing. QMRA risk estimates and TTP both revealed that risk attribution from grinding was mainly influenced by sharpness of grinder knife > specific grinder > grinding temperature whereas the specific pathogen was of minor importance.
Restriktiv anvendelse af antibiotika i økologisk husdyrproduktion: potentielle for mere sikre kvalitetsprodukter med færre resistente bakterier

Robustness of a cross contamination model describing transfer of pathogens during grinding of meat

Salmonella Dublin i oksekød, 2014
Analysis of dynamic changes in the meat microbiota during varied temperature exposures - a novel method to estimate temperature history and pathogen growth in meat

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Contributors: Buschhardt, T., Aabo, S., Hansen, T. B.
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Buffer capacity of food components influences the acid tolerance response in Salmonella Typhimurium during simulated gastric passage

Food composition, buffer capacity, and fat and protein content have been shown to effect the gastric acid survival of pathogens (Waterman & Smali 1998). In this study, simple food-model substances with different buffer capacities were investigated for their ability to support survival of stationary phase Salmonella Typhimurium during simulated gastric acid passage. We used a computer-controlled fermentor to employ pH changes in synthetic gastric fluid, mimicking the dynamic pH during gastric passage. In order to minimise variation, Salmonella enterica serovar Typhimurium was contained in dialysis tubes, enabling simultaneous testing of biological triplicates under varying conditions. Surprisingly, we found that less buffered media provided higher protection of Salmonella, compared to media with high buffer capacity. By investigating the relative gene expression of rpoS and ompR encoding for two major stationary phase ATR regulators, we found an approx. four-fold increase in expression of ompR and an approx. three-fold increase of rpoS in saline and buffered saline, respectively, after 15 min of gastric acid challenge. The relative expression of these genes, were significantly lower in Brain Heart Infusion Broth having a higher buffer capacity. We suggest this to be associated with a varying ability of Salmonella Typhimurium to mount a stationary phase acid tolerance response (ATR) depending on the buffer capacity of the food vehicle.

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Buffer capacity of food components influences the acid tolerance response in Salmonella Typhimurium during simulated gastric passage

General information
Fly larvae as sustainable bioconverters of waste for feed in the future

How to provide enough food and feed for the growing population is a major challenge for the next generation. Improved economy in many developing countries increases the demand for protein from meat or fish. This may lead to depletion of the seas and overexploitation of agricultural land in the search for obtaining sufficient food. Traditional food production creates large amounts of organic waste streams which are dumped or used for biogas production. Although some of these waste categories have large potential for upcycling to feed for animals or food for humans, then drivers for change have been hampered by low human perception, poor economy and regulations. This has delayed the biological and technological developments in the area.

Insects are natural converters of waste and have great potential for upcycling low value byproducts or waste materials as animal manure. They have much higher feed conversion rate compared to conventional livestock, low use of water and energy, and with at much lower requirements for production area. Furthermore the emission of greenhouse gases and ammonia compared to production with pigs and cattle is much lower. Harvested insects may be used direct as food or feed, or nutrients may be refined from processed insects, however there is a huge need for technological development in order to automate culture and harvest of the insects. In nature insects and insect larvae are important feed sources for poultry and the larva of the common housefly (Musca domestica) have been shown to be especially rich in essential amino and fatty acids. At the Food institute we have investigated in feed safety of using these fly larvae as feed for egg laying hens. The larvae were reared on poultry manure which implies the risk of transmission of pathogenic microorganisms between animals and to humans, as well as accumulation of chemical compounds from the manure. However, we found that the insects were able to actively degrade a number of important pathogenic bacteria during the conversion of the manure. Environmental pollutants as dioxins and PCB were higher in the larvae that in the manure, indicating that these substances could be accumulated in the larvae. Feeding trials of chickens and egg laying hens with insect supplements showed superior growth results compared to standard feed, showing inclusion of insects in future poultry diet is an sustainable and attractive alternative to other protein sources.
The role of ClpP, RpoS and CsrA in growth and filament formation of Salmonella enterica serovar Typhimurium at low temperature

Background: Salmonellae are food-borne pathogens of great health and economic importance. To pose a threat to humans, Salmonellae normally have to cope with a series of stressful conditions in the food chain, including low temperature. In the current study, we evaluated the importance of the Clp proteolytic complex and the carbon starvation protein, CsrA, for the ability of Salmonella Typhimurium to grow at low temperature. Results: A clpP mutant was severely affected in growth and formed pin point colonies at 10 degrees C. Contrary to this, rpoS and clpP/rpoS mutants were only slightly affected. The clpP mutant formed cold resistant suppressor mutants at a frequency of 2.5 x 10(-3) and these were found not to express RpoS. Together these results indicated that the impaired growth of the clpP mutant was caused by high level of RpoS. Evaluation by microscopy of the clpP mutant revealed that it formed filamentous cells when grown at 10 degrees C, and this phenotype too, disappered when rpoS was mutated in parallel indicating a RpoS-dependency. A csrA (sup) mutant was also growth attenuated a low temperature. An rpoS/csrA (sup) double mutant was also growth attenuated, indicating that the phenotype of the csrA mutant was independent from RpoS. Conclusions: The cold sensitivity of clpP mutant was associated with increased levels of RpoS and probably caused by toxic levels of RpoS. Although a csrA mutant also accumulated high level of RpoS, growth impairment caused by lack of csrA was not related to RpoS levels in a similar way.
ClpP deletion causes attenuation of Salmonella Typhimurium virulence through mis-regulation of RpoS and indirect control of CsrA and the SPI genes

Salmonella enterica serovar Typhimurium requires the type III secretion system encoded by Salmonella pathogenicity island 1 (SPI1) and controlled by the master regulator, HilA, to penetrate the intestinal epithelium. Numerous regulators affect virulence through influence on this system, including the proteolytic component ClpP, the stationary phase regulator RpoS and the carbon-storage regulator CsrA. However, the mechanism behind the ClpP regulation is not fully understood.

To elucidate this we examined differentially expressed genes in a ΔclpP mutant compared with WT using global transcriptomic analysis. SPI1 and SPI4 virulence genes were significantly downregulated in the ΔclpP mutant, whereas several RpoS-dependent genes and the fliC gene encoding flagellin were upregulated. While the ΔclpP mutant was attenuated in cell invasion, this attenuation was not present in a ΔclpP/rpoS::amp double mutant, suggesting the repression of invasion was directed through RpoS. The expression of the csrA virulence regulator was increased in the ΔclpP mutant and decreased in the rpoS::amp and ΔclpP/rpoS::amp mutants, indicating that ClpP affects the csrA expression level as well. Thus, this study suggests that ClpP affects SPI1 expression and thereby virulence indirectly through its regulation of both RpoS and CsrA.

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Organisations: Department of Systems Biology, Center for Systems Microbiology, National Food Institute, Division of Food Microbiology, University of Nottingham, Veterinary Research Institute, University of Copenhagen
Contributors: Knudsen, G. M., Olsen, J. E., Aabo, S., Barrow, P., Rychlik, I., Thomsen, L. E.
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Combining predictive microbiology with cold-enrichment in minced pork for quantifying low levels of Salmonella Typhimurium DT104

OBJECTIVE

For determination of Salmonella concentration in meat various methods can be used depending on the expected level. When higher levels (102 to 103 bacteria or more per g) are anticipated, plate count techniques using selective agars, i.e. XLD, are appropriate whereas for low numbers (3 to 102 bacteria per g) a most probable number (MPN) method is recommended. Recently, a real-time PCR-based tool for determination of concentrations as low as 1.4 Salmonella per 20 cm (approx. 10 g) of cork-borer samples of pig carcasses has been developed (Krämer et al. 2011). However, compared to plate count techniques the MPN and real-time PCR methods are very labour intensive and might not be suitable when analysing many samples within a short timeframe. We suggest to use enrichment in the meat at relatively low temperatures (11 to 16°C) combined with predictive models as an alternative. Therefore, the objective of this study was to evaluate the possibility to carry out a Salmonella enrichment step in the meat itself and use the two species interaction model, presented by Møller et al. (2013), for quantifying levels of Salmonella Typhimurium DT104 in minced pork.

METHODS

A total number of 101 minced pork samples were inoculated artificially with various concentrations (from 10 to 106 bacteria per g) of stationary phase S. Typhimurium DT104. Counts of S. Typhimurium DT104 as well as natural microbiota in the samples were determined immediately after inoculation and again after an enrichment step in the minced meat for approx. 48 h at 11 – 16°C. A rearranged version of the expanded Jameson-effect species interaction model, suggested by Møller et al. (2013), was applied for prediction of the Salmonella concentration in the minced pork samples. Observed and predicted counts of S. Typhimurium DT104 (log10-units) prior to enrichment were compared visually and by the acceptable prediction zone (APZ) method, i.e. percentage of predictions being within ±0.5 log10-units of observed values.

RESULTS

A relatively good agreement between predicted and observed values was seen. However, only 56 % of the predictions were within the APZ. The model tended to over-predict counts from 3 log-units and above, whereas under-prediction to some extent was seen for counts below 3 log10-units. Over-prediction was most likely explained by uncertainty of the lag-time model for Salmonella, i.e. a short lag time would result in a lower initial count to get to the same count after enrichment as compared to a long lag time. In contrast, part of the under-prediction appeared to coincide with competitive growth of Citrobacter braakii and Hafnia alvei on the selective agar. Therefore, under-prediction more likely resulted from underestimation of the Salmonella count after enrichment. Whether competition between these species also took place in the meat during enrichment is not known. However, as the observed levels of the competitive species were below 5.5 log10-units it is questionable whether interaction with S. Typhimurium DT104 in the pork could have occurred. Omitting these samples and using the 56 observations below 3 log10-units improved the percentage of predictions within APZ to 63 %.

CONCLUSIONS AND IMPACT OF THE STUDY

A novel approach for determining Salmonella counts at low concentrations was proposed. Applying a simple plate count method, after cold enrichment (11-16°C for 2 d) in the pork sample itself in combination with predictive growth models, showed promising results. It indicates the potential of this approach as an alternative to meet the need for more sensitive methods, which are simple enough to be used in large-scale series of analysis.
Correlation between Salmonella and hygiene indicators in the Danish fresh pork chain

Salmonella in pork is estimated to be the source to 200 – 400 registered cases of salmonellosis annually in Denmark. Hygiene performance during handling in all parts of the fresh pork chain will potentially contribute to the safety of the meat. This study describes the occurrence of Salmonella in 1,569 samples from cutting plants, and in 1,232 samples from retail supermarkets and butcher shops sampled from June 2010 to March 2011 and associates this to two hygiene indicators, enterococci and Enterobacteriaceae.

In six large cutting plants, Salmonella was isolated from 1.3 % compared 3.7 % of samples in 12 smaller plants. Process hygiene was described by quantifying Enterobacteriaceae and enterococci in samples and high levels of both were mostly seen for smaller plants. Enterococci counts varied more between plants than Enterobacteriaceae. Occurrence of Salmonella was positively correlated to the number of enterococci. If >10,000 enterococci/g were present, the sample was 14 times more likely to contain Salmonella compared to samples with fewer enterococci.

At retail, Salmonella was found in 0.72 % of cuttings from 278 supermarkets compared to 1.0 % for 134 butcher shops. Among samples, 4 % from supermarkets and 12 % from butcher shops contained enterococci. Samples containing enterococci were six times more likely to contain Salmonella whereas no correlation was found between Enterobacteriaceae and Salmonella in retail samples.

In conclusion, presence of Salmonella was associated with lower hygiene as indicated by high levels of either Enterobacteriaceae or enterococci. A positive correlation between enterococci and Salmonella was observed. In particular, smaller cutting plants had problems with hygiene and produced meat of higher consumer risk. To some extend this was also valid for butcher shops pointing at a need for interventions targeting smaller enterprises.

Effect of natural microbiota on growth of Salmonella spp. in fresh pork – A predictive microbiology approach

This study was undertaken to model and predict growth of Salmonella and the dominating natural microbiota, and their interaction in ground pork. Growth of Salmonella in sterile ground pork at constant temperatures between 4 °C and 38 °C was quantified and used for developing predictive models for lag time, max. specific growth rate and max. population density. Data from literature were used to develop growth models for the natural pork microbiota. Challenge tests at temperatures from 9.4 to 24.1 °C and with Salmonella inoculated in ground pork were used for evaluation of interaction models. The existing Jameson-effect and Lotka–Volterra species interaction models and a new expanded Jameson-effect model were evaluated. F-test indicated lack-of-fit for the classical Jameson-effect model at all of the tested temperatures and at 14.1–20.2 °C this was caused by continued growth of Salmonella after the natural microbiota had reached their max. population density. The new expanded Jameson-effect model and the Lotka–Volterra model performed better and appropriately described the continued but reduced growth of Salmonella after the natural microbiota had reached their max. population density. The expanded Jameson-effect model is a new and simple species interaction model, which performed as well as the more complex Lotka–Volterra model.
Escherichia coli as indicator of the human Salmonella risk caused by consumption of pork

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Intestinal invasion of Salmonella enterica serovar Typhimurium in the avian host is dose dependent and does not depend on motility and chemotaxis

Salmonella enterica serotype Typhimurium (S. Typhimurium) can invade in the intestine of the avian host, and knowledge on the mechanisms that govern this is potentially important for prevention of disease. This study investigated the invasion of S. Typhimurium in the avian host and to which extent it depended on motility and chemotaxis. Wild type and previously well-characterized transposon mutants in flagella genes fliC and fljB and in chemotaxis genes cheA, cheB and cheR were used as challenge strains in intestinal loop experiments. Invasion was shown to be dose dependent, but did not require functional flagella or chemotaxis genes. In support of the results from intestinal loop experiments, flagella and chemotaxis genes were not significantly important to the outcome of an oral infection. The results showed that S. Typhimurium invasion in the avian host was dose dependent and was not affected by the loss of flagella and chemotaxis genes.

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Contributors: Olsen, J. E., Hoegh-Andersen, K. H., Rosenkrantz, J. T., Schroll, C., Casadesüs, J., Aabo, S., Christensen, J. P.
Pages: 373-377
Prediction of Salmonella carcass contamination by a comparative quantitative analysis of E. coli and Salmonella during pig slaughter

Faecal contamination of carcasses in the slaughterhouse is generally considered to be the source of Salmonella on pork. In this study the hygiene indicator Escherichia coli is used to quantify faecal contamination of carcasses and it is hypothesized that it can be used to predict the quantitative carcass contamination with Salmonella, when the distribution of Salmonella concentrations in faeces is known. Paired pig sample data (faecal samples and carcass swabs) were obtained from five slaughterhouses and analysed for prevalence and concentrations of E. coli and Salmonella. A simple model was developed to describe the faecal contamination of carcasses using the E. coli data. The E. coli results suggested different hygiene performances in different slaughterhouses, and showed that a model assuming that carcasses are predominantly contaminated by their own faeces was not appropriate. Observed Salmonella prevalences were low (on average 1.9% on carcasses) and between slaughterhouses the prevalences ranked differently than the hygiene performance based on the E. coli data suggested. Also, the Salmonella concentrations predicted using E. coli as a faecal indicator were lower than the observed Salmonella concentrations. It is concluded that the faecal carriage of Salmonella together with the faecal contamination of carcasses, as predicted from E. coli data in the animal faeces and hygiene performance of the slaughterhouse, is not sufficient to explain carcass contamination with Salmonella. Our extensive data set showed that other factors than the observed faecal carriage of Salmonella by the individual animals brought to slaughter, play a more important role in the Salmonella carcass contamination of pork.

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Restricted use of antibiotics in organic pig farming
Can the restricted use of antibiotics in organic pig farming be documented to provide a safer, high quality meat product with less antibiotic resistant bacteria? The project SafeOrganic aims to document that the restricted use of antimicrobials in organic pig production leads to lower levels of antibiotic resistant bacteria compared with the level in conventional pigs. However, the project will also address the risk of losing this quality parameter, due to a widespread practice of slaughtering organic pigs together with conventional pigs, implying a risk of cross-contamination.

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Salmonella and indicator bacteria in pork: a comparison of butcher shops and supermarkets

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Yersinia enterocolitica

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Antibiotic usage in organic pigs - Will consumers benefit from restricted antibiotic usage in organic pigs?

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Contributors: Aabo, S., Ricci, A., Denis, M., Bengtsson, B., Dalsgaard, A., Rychlik, I., Jensen, A. N.
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"Conferm" - a new tool to predict reduction of pathogens during production of fermented and matured sausages

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Correlation between Salmonella and hygiene indicators in the Danish fresh pork chain

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Correlation between Salmonella and hygiene indicators in the Danish fresh pork chain

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Research output: Chapter in Book/Report/Conference proceeding
Dietary proteins extend the survival of salmonella dublin in a gastric Acid environment.

The pH of the human stomach is dynamic and changes over time, depending on the composition of the food ingested and a number of host-related factors such as age. To evaluate the number of bacteria surviving the gastric acid barrier, we have developed a simple gastric acid model, in which we mimicked the dynamic pH changes in the human stomach. In the present study, model gastric fluid was set up to imitate pH dynamics in the stomachs of young and elderly people after ingestion of a standard meal. To model a serious foodborne pathogen, we followed the survival of Salmonella enterica serotype Dublin, and found that the addition of proteins such as pepsin, ovalbumin, and blended turkey meat to the simple gastric acid model significantly delayed pathogen inactivation compared with the control, for which no proteins were added. In contrast, no delay in inactivation was observed in the presence of bovine serum albumin, indicating that protection could be protein specific. The simple gastric acid model was validated against a more laborious and complex fermenter model, and similar survival of Salmonella Dublin was observed in both models. Our gastric acid model allowed us to evaluate the influence of food components on survival of pathogens under gastric conditions, and the model could contribute to a broader understanding of the impact of specific food components on the inactivation of pathogens during gastric passage.
Evaluation of growth potential of Listeria monocytogenes and Salmonella in a sandwich environment

General information
Publication status: Published
Organisations: National Food Institute, Division of Food Microbiology
Contributors: Birk, T., Aabo, S., Hansen, T. B.
Number of pages: 1
Publication date: 2012
Peer-reviewed: Yes

Host publication information
Title of host publication: 2012 Symposium of The Danish Microbiological Society
Publisher: DMS

Bibliographical note
P60
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 2012 › Research › peer-review
Evaluation of growth potential of *Listeria monocytogenes* and *Salmonella* in a sandwich environment

**General information**

Publication status: Published
Organisations: National Food Institute, Division of Food Microbiology
Contributors: Birk, T., Bollerslev, A. M., Møller, C., Aabo, S., Hansen, T. B.
Number of pages: 1
Publication date: 2012
Peer-reviewed: Yes
Electronic versions:

11.pdf
Research output: Contribution to conference › Poster – Annual report year: 2013 › Research › peer-review

Evaluation of intestinal sampling sites in pigs at slaughter for assessing antibiotic resistance level in swine herds

In the EU project SafeOrganic, the objective is to compare the level of antibiotic resistance in conventional pig herds with the level in organic pig herds, where a restricted use of antimicrobials is expected to result in less resistant bacteria. For such survey, sampling at the abattoir opposed to at each individual herd would reduce the work load and costs significantly. However, due to the potential oral exposure to bacteria in the environment during transport and lairage of pigs, intestinal content sampled at the slaughterhouse may not represent the bacterial status of the pig back in the herd. To assess this, we examined the gastrointestinal passage velocity via the oral route. In addition, we compared the proportion of resistant *Escherichia coli* in rectal swabs sampled at the farm with the proportion in different segments of the large intestine at slaughter, as a measure of any induced change in the pigs' bacterial community from farm to slaughterhouse. Twelve slaughter pigs were fed with inert particles before transport to the slaughterhouse, where the pigs were slaughtered approx. 2, 4, 6 and 8 h after feeding. The large intestine of each pig was examined for localization of the particles and the numbers of *E. coli* in rectal swabs (farm) and faecal content from caecum, mid-colon and end-colon was enumerated on 3M Select *E. coli* Count plates (SEC) with or without tetracycline (TET) to determine the proportion of TET resistant *E. coli*.

Four hours after feeding, the particles was located in the mid-colon in some pigs indicating a relatively short intestinal passage time after ingestion and then the risk of finding bacteria not originating from the host pig but from the environment. However, the proportion of the TET resistant *E. coli* in the large intestine appeared relatively stable over time, though generally a little lower than in rectal swabs. Accordingly, it seems that testing for the level of TET resistant *E. coli* at slaughter can allow for comparison of the presence of TET resistance also at herd level. Ongoing investigations of pigs from different herds should allow for further conclusions on this.

**General information**

Publication status: Published
Organisations: National Food Institute, Division of Food Microbiology, Technical University of Denmark
Contributors: Jensen, A. N., Thanou, O., Axelsdottir, A., Gerling Thomsen, S., Aabo, S.
Number of pages: 1
Publication date: 2012

**Host publication information**

Title of host publication: XXIII FoodMicro 2012 : Abstract Book
Place of publication: Istanbul
ISBN (Print): 978-975-561-123-6
Electronic versions:

1.pdf

**Bibliographical note**

Poster P204 and abstract no. 1164
Source: dtu
Source-ID: u::6140
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 2012 › Research › peer-review

Evaluering af salmonellahandlingsplanen for svin (SHIV) 2009-2011: Evaluering af salmonellahandlingsplanen for svin (SHIV) 2009-2011

**General information**

Publication status: Published
Organisations: National Food Institute, Division of Epidemiology and Microbial Genomics, Division of Food Microbiology
Contributors: Teknikergruppen for Salmonellahandlingsplan IV
Forekomst af indikatorbakterier og Salmonella i svinekød og på udstyr hos detailslagtere: Foreløbig opgørelse af detailledsprojekt CKL 2009-20-64-00179

Growth potential of Listeria monocytogenes and Salmonella in a sandwich environment
Interaction between starter culture and Salmonella virulence

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment
Contributors: Henriksen, S., Aabo, S.
Number of pages: 1
Publication date: 2012
Peer-reviewed: Yes
Event: Poster session presented at 9th Symposium on Food Microbiology, Helsingør, Denmark.

Electronic versions:
lmc_2011_poster.pdf
Source: dtu
Source-ID: u::3560
Research output: Contribution to conference › Poster – Annual report year: 2012 › Research › peer-review


General information
Publication status: Published
Organisations: National Food Institute, Division of Epidemiology and Microbial Genomics, Division of Food Microbiology
Contributors: Teknikergruppen for Salmonellahandlingsplan IV i svin
Number of pages: 33
Publication date: 2012

Publication information
Publisher: DTU Fødevareinstituttet, Fødevarestyrelsen, Landbrug og Fødevarer, Teknologisk Institut, Danske Slagtermestres Landsforening og Eurofins| Steins Laboratorium
Original language: Danish
Source: PublicationPreSubmission
Source-ID: 103486738
Research output: Book/Report › Report – Annual report year: 2012 › Commissioned › peer-review

Salmonella surveillance and control for finisher pigs and pork in Denmark — A case study
Salmonella can either be controlled pre-harvest, post-harvest or by a combination of both approaches. This paper describes the lessons learned in Danish Salmonella surveillance and control programme for finisher pigs and pork. Initially, main focus was on pre-harvest initiatives and correct identification of herds with respect to the risk for Salmonella that they represented. However, an analysis of risk-mitigating actions applied along the chain from stable to table showed that it would be more cost-effective to deal with Salmonella on the abattoirs than in the herds. This knowledge moved focus from pre- to post-harvest without giving up on pre-harvest surveillance. First of all, this meant increased attention on slaughter hygiene and individual interventions in the abattoirs. In brief, we learned that for a programme to be successful it must be based on standardised methods for sampling and testing to be able to evaluate and compare performance of the programme. More specifically, meat-juice samples taken from finisher pigs at the time of slaughter are an effective way of identifying high-risk herds for Salmonella. In addition, a penalty system might act as an incentive for farmers to deal with Salmonella in their herd. Additionally, common targets for all abattoirs allowing for unique control solutions should be adapted. Finally, decontamination techniques like hot water decontamination are a feasible way of dealing with high-risk pigs (Level-3 pigs). The current prevalence in Danish pork is around 1.2%, and a target is set to

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment, Danish Agriculture and Food Council, Danish Technological Institute, University of Copenhagen
Contributors: Alban, L., Baptista, F., Møgelmose, V., Sørensen, L., Christensen, H., Aabo, S., Dahl, J.
Pages: 656-665
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: Food Research International
Volume: 45
Issue number: 2
ISSN (Print): 0963-9969
Ratings:
Survival and Growth of Epidemically Successful and Nonsuccessful Salmonella enterica Clones after Freezing and Dehydration.

The spread of epidemically successful nontyphoidal Salmonella clones has been suggested as the most important cause of salmonellosis in industrialized countries. Factors leading to the emergence of success clones are largely unknown, but their ability to survive and grow after physical stress may contribute. During epidemiological studies, a mathematical model was developed that allowed estimation of a factor (q) accounting for the relative ability of Salmonella serovars with different antimicrobial resistances to survive in the food chain and cause human disease. Based on this q-factor, 26 Salmonella isolates were characterized as successful or nonsuccessful. We studied the survival and growth of stationary- and exponential-phase cells of these isolates after freezing for up to 336 days in minced meat. We also investigated survival and growth after dehydration at 10°C and 82% relative humidity (RH) and 25°C and 49% RH for 112 days. Stationary-phase cells were reduced by less than 1 log unit during 1 year of freezing, and growth was initiated with an average lag phase of 1.7 h. Survival was lower in exponential-phase cells, but lag phases tended to be shorter. High humidity and low temperature were less harmful to Salmonella than were low humidity and high temperature. Tolerance to adverse conditions was highest for Salmonella Infantis and one Salmonella Typhimurium U292 isolate and lowest for Salmonella Derby and one Salmonella Typhimurium DT170 isolate. Dehydration, in contrast to freezing, was differently tolerated by the Salmonella strains in this study, but tolerance to freezing and dehydration does not appear to contribute to the emergence of successful Salmonella clones.

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment, Technical University of Denmark
Contributors: Müller, K., Aabo, S., Birk, T., Mordhorst, H., Bjarnadóttir, B., Agersø, Y.
Pages: 456-464
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: Journal of Food Protection
Volume: 75
Issue number: 3
ISSN (Print): 0362-028X
Ratings:
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.03 SJR 1.087 SNIP 0.981
Web of Science (2012): Impact factor 1.832
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Original language: English
DOI:
10.4315/0362-028X.JFP-11-167
Source: dtu
Source-ID: n:oai:DTIC-ART:pubmed/344541691::15230
Research output: Contribution to journal › Journal article – Annual report year: 2012 › Research › peer-review
General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Copenhagen
Contributors: Morild, R. K., Olsen, J. E., Aabo, S.
Pages: 353-358
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: International Journal of Food Microbiology
Volume: 145
Issue number: 1
ISSN (Print): 0168-1605
Ratings:
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 3.63 SJR 1.593 SNIP 1.713
Web of Science (2011): Impact factor 3.327
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Original language: English
Keywords: Salmonella Typhimurium, Listeria monocytogenes, Attachment, Pork, Decontamination, Yersinia enterocolitica
DOIs:
10.1016/j.ijfoodmicro.2010.12.018

Source: orbit
Source-ID: 277317
Research output: Contribution to journal › Journal article – Annual report year: 2011 › Research › peer-review

European Food Safety Authority, European Centre for Disease Prevention and Control; The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2009

The European Food Safety Authority and the European Centre for Disease Prevention and Control have analysed the information on the occurrence of zoonoses and food-borne outbreaks in 2009 submitted by 27 European Union Member States. In 2009, 108,614 salmonellosis cases in humans were reported and the statistically significant decreasing trend in the case numbers continued. Eighteen Member States reached the European Union Salmonella reduction target for breeding flocks of fowl, 17 Member States met their reduction target for laying hens and 18 Member States met the reduction target for broilers. In foodstuffs, Salmonella was most often detected in fresh poultry and pig meat. Campylobacteriosis was the most commonly reported zoonosis with 198,252 human cases. Campylobacter was most often detected in fresh broiler meat. The number of listeriosis cases in humans increased by 19.1 % compared to 2008, with 1,645 cases in 2009. Listeria was seldom detected above the legal safety limit from ready-to-eat foods. Member States reported 3,573 verotoxigenic Escherichia coli (VTEC), 7,595 yersiniosis and 401 brucellosis cases in humans, while VTEC bacteria were mostly found from cattle and bovine meat and Yersinia from pigs and pig meat. Brucellosis and tuberculosis decreased in cattle, sheep and goat populations. In humans 1,987 Q fever cases were detected and Q fever was found in domestic ruminants. Trichinelliosis and echinococcosis caused 748 and 790 human cases, respectively, and Trichinella and Echinococcus were mainly detected in wildlife. There were 1,259 human cases of toxoplasmosis reported and in animals Toxoplasma was most often found in sheep and goats. Rabies was recorded in one person in the European Union and the disease was also found in animals. Most of the 5,550 reported food-borne outbreaks were caused by Salmonella, viruses and bacterial toxins and the most important food sources were eggs, mixed or buffet meals and pig meat.
Inactivation of pathogens on pork by steam-ultrasound treatment

The objective of the study was to evaluate a new pathogen inactivation concept that combines application of pressurized steam simultaneously with high-power ultrasound through a series of nozzles. On skin and meat surfaces of pork jowl samples, counts of total viable bacteria were reduced by 1.1 log CFU/cm(2) after treatment for 1 s and by 3.3 log CFU/cm(2) after treatment for 4 s. The mean reduction of 1.7 to 3.3 log CFU/cm(2) on the skin surface was significantly higher than the reduction of 1.1 to 2.5 log CFU/cm(2) on the meat surface. The inactivation of Salmonella Typhimurium, Salmonella Derby, Salmonella Infantis, Yersinia enterocolitica, and a nonpathogenic Escherichia coli was studied on inoculated samples that were treated for 0.5 to 2.0 s. With one exception, no significant differences in reduction were observed among the bacterial types. After treatment for 0.5 s, the 0.9-to 1.5-log reductions of E. coli were significantly higher than the 0.4- to 1.1-log reductions for Salmonella and Y. enterocolitica. Overall, reductions increased by increasing treatment time; reductions were 0.4 to 1.5 log CFU/cm(2) after treatment for 0.5 s and 2.0 to 3.6 log CFU/cm(2) after treatment for 2 s. Reductions on the skin (1 to 3.6 log CFU/cm(2)) were significantly higher than reductions on the meat surface (1 to 2.5 log CFU/cm(2)). The reduced effect on the meat surface may be explained by greater protection of bacteria in deep structures at the muscle surface. No significant difference in reduction was observed between samples inoculated with 10(4) CFU/cm(2) and those inoculated with 10(7) CFU/cm(2), and cold storage of samples for 24 h at 5°C after steam-ultrasound treatment did not lead to changes in recovery of bacteria.

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment, FORCE Technology, University of Copenhagen
Contributors: Morild, R. K., Christiansen, P., Sørensen, A. M. H., Nonboe, U., Aabo, S.
Pages: 769-775
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Journal of Food Protection
Volume: 74
Issue number: 5
ISSN (Print): 0362-028X
Ratings:
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.96 SJR 0.97 SNIP 0.958
Web of Science (2011): Impact factor 1.937
ISI indexed (2011): ISI indexed yes
Method Enabling Gene Expression Studies of Pathogens in a Complex Food Matrix

We describe a simple method for stabilizing and extracting high-quality prokaryotic RNA from meat. Heat and salt stress of Escherichia coli and Salmonella spp. in minced meat reproducibly induced dnaK and otsB expression, respectively, as observed by quantitative reverse transcription-PCR (>5-fold relative changes). Thus, the method is applicable in studies of bacterial gene expression in a meat matrix.

Prevalence and risk factors for Salmonella in veal calves at Danish cattle abattoirs

The study's objectives were to determine herd- and animal-level prevalence and herd-level risk factors for Salmonella in dairy-bred veal calves at slaughter in Denmark. In total, 1296 faecal samples were collected at five cattle abattoirs in Denmark during 2007-2008. The animals came from 71 randomly selected specialized veal-calf producers that delivered more than 100 animals to slaughter per year. Salmonella Dublin bacteria were isolated from 19 samples from 12 herds and Salmonella Typhimurium was isolated from one sample. The apparent prevalence of herds delivering Salmonella-shedding animals to slaughter was 18% (95% CI 9-27). The overall estimated true prevalence of shedding calves at slaughter was 1.3%. Veal-calf herds that purchased animals from herds not classified as low risk in the Danish Salmonella surveillance programme had significantly (P = 0.03) higher risk of delivering Salmonella-shedding calves to slaughter. The results emphasize the importance of efforts in the dairy industry to ensure food safety for consumers.
Quantifying the effect of natural microbiota on growth of Salmonella Typhimurium DT104 and Salmonella Derby in fresh pork

General information
Publication status: Published
Organisations: National Food Institute, Division of Food Microbiology, Division of Industrial Food Research, University of Copenhagen, University of Bonn
Contributors: Møller, C. O. D. A., Ilg, Y., Aabo, S., Dalgaard, P., Bak Christensen, B., Hansen, T. B.
Number of pages: 1
Publication date: 2011
Peer-reviewed: Yes
Event: Poster session presented at 9th International Conference on the Epidemiology and Control of Biological Chemical and Physical Hazards in Pigs and Pork, Maastricht, Netherlands.
Electronic versions:
Hansen_Final.pdf
Source: PublicationPreSubmission
Source-ID: 93297027
Research output: Contribution to conference › Poster – Annual report year: 2011 › Research › peer-review

Quantifying the effect of natural microflora on growth of salmonellae in fresh pork

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Bonn
Contributors: Birk, T., Hansen, T. B., Møller, C., Ilg, Y., Aabo, S., Dalgaard, P., Christensen, B. B.
Number of pages: 168
Publication date: 2011

Host publication information
Title of host publication: Safepork 2011 : Abstract Book
Electronic versions:
plugin-SP010_abstractbook_web_140611.pdf
URLs:
http://www.safepork.org/
Source: orbit
Source-ID: 277976
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 2011 › Research

Quantifying the effect of natural microflora on growth of Salmonella Typhimurium DT104 and Salmonella Derby in fresh pork

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Bonn
Contributors: Møller, C., Ilg, Y., Aabo, S., Dalgaard, P., Christensen, B. B., Hansen, T. B.
Publication date: 2011
Suggestion for a decision support tool (DST) for corrective storage of sausages suspected of VTEC survival during fermentation and maturation

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Danish Technological Institute
Contributors: Hansen, T. B., Gunvig, G., Larsen, H. D., Hansen, F., Aabo, S.
Pages: 122-125
Publication date: 2011

Host publication information
Title of host publication: Predictive Modelling of Food Quality and Safety: Conference Proceedings
Editors: Cummins, E., Frias, J. M., Valdramidis, V. P.
Keywords: Corrective Action, CCP, VTEC 026:H-, VTEC 0157, VTEC 0111:H-
URLs:
http://www.eventelephant.com/pmf7
Survival and growth of exponential and stationary phase Salmonella during fermentation of sausage

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Birk, T., Müller, K., Hansen, T. B., Aabo, S.
Publication date: 2011
Peer-reviewed: No
Event: Poster session presented at 9th International Conference on the Epidemiology and Control of Biological Chemical and Physical Hazards in Pigs and Pork, Maastricht, Netherlands.
Electronic versions:
Birk.pdf
URLs:
http://www.safepork.org/
Source: orbit
Source-ID: 278027
Research output: Contribution to conference › Poster – Annual report year: 2011 › Research

Survival of Salmonella on cuts of beef carcasses subjected to dry aging

Aims: The aim of this study was to determine the survival of 15 different strains of Salmonella of selected serotypes during prolonged cold storage of beef. Methods and Results: Fifteen strains of eight different serotypes of Salmonella were spiked onto fresh cuts beef portions, and the survival was followed during storage in a laboratory cooling system. Over a 14-day period, all strains were reduced significantly in numbers; however, strains of Salmonella Typhimurium DT104 and Salmonella Enteritidis PT4 and PT8 survived significantly longer than strains of the serovars Dublin, Derby, Infantis and Newport. For five selected strains, the observations were verified in a pilot plant cooling facility mimicking industrial cooling. No significant differences in reduction were found between the two cooling methods. Conclusions: A significant reduction in Salmonella can be obtained by dry aging of beef during cold storage but the survival is strain dependent. Significance and Impact of the Study: From a hygienic point of view, cold storage of unpacked beef, which is still performed in small slaughterhouses, is a good alternative to vacuum packaging.

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment, Danish Veterinary and Food Administration, University of Copenhagen
Contributors: Knudsen, G. M., Sommer, H. M., Sørensen, N., Olsen, J. E., Aabo, S.
Pages: 848-854
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Journal of Applied Microbiology
Volume: 111
Issue number: 4
ISSN (Print): 1364-5072
Ratings:
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.55
Web of Science (2011): Impact factor 1.622
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Original language: English
Keywords: Chilling, Beef, Dry aging, Salmonella
DOIs:
10.1111/j.1365-2672.2011.05094.x
Source: orbit
Source-ID: 283759
Research output: Contribution to journal › Journal article – Annual report year: 2011 › Research › peer-review
Description of Extended Pre-Harvest Pig Salmonella Surveillance-and-Control Programme and its Estimated Effect on Food Safety Related to Pork

Salmonella in pork can be combated during pre- or post-harvest. For large slaughterhouses, post-harvest measures like decontamination might be cost-effective while this is less likely with small-to-medium sized slaughterhouses. In this study, pre-harvest measures might be more relevant. We describe an extended surveillance-and-control programme for Salmonella in finisher pigs, which, to establish equivalence to the Swedish control programme, is intended for implementation on the Danish island, Bornholm. The effect of the programme on food safety was estimated by analysing Salmonella data from pig carcasses originating from herds that would have qualified for the programme during 2006–2008. Food safety was interpreted as prevalence of Salmonella on carcasses as well as the estimated number of human cases of salmonellosis related to pork produced within the programme. Data from the Danish Salmonella programme were obtained from Bornholm. We used a simulation model developed to estimate the number of human cases based on the prevalence of Salmonella on carcass swabs. Herds are only accepted in the programme if they have one or less seropositive sample within the previous 6 months. In this way, the Salmonella load is kept to a minimum. The programme is not yet in operation and pigs that qualify for the programme are currently mixed at slaughter with those that do not qualify. Therefore, we had to assess the impact on the carcass prevalence indirectly. The prevalence of Salmonella in carcass swabs among qualifying herds was 0.46% for the 3 years as a whole, with 2006 as the year with highest prevalence. According to the simulation the expected number of human cases relating to pork produced within the programme was below 10. When the programme is in operation, an extra effect of separating pigs within the programme from those outside is expected to lower the prevalence of Salmonella even further.

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment
Pages: 6-15
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Zoonoses and Public Health
Volume: 57
Issue number: 1
ISSN (Print): 1863-1959
Ratings:
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.857 SNIP 1.145
Web of Science (2010): Impact factor 2.22
Web of Science (2010): Indexed yes
Original language: English
DOI: 10.1111/j.1863-2378.2010.01367.x
Source: orbit
Source-ID: 270864
Research output: Contribution to journal › Journal article – Annual report year: 2010 › Research › peer-review

Effect of natural microflora on growth of Salmonella in fresh pork meat - a predictive microbiology approach

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Division of Seafood Research, FoodDTU, University of Bonn
Contributors: Møller, C., Kampmann, Y., Aabo, S., Christensen, B. B., Dalgaard, P., Hansen, T. B.
Number of pages: 51
Publication date: 2010

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Title of host publication: FMN - 8th Symposium on Food Microbiology : 2-3 June 2010
Publisher: The Centre for Advanced Food Studies (LMC)
Source: orbit
Source-ID: 263673
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 2010 › Research
Effect of natural microflora on growth of Salmonella in fresh pork meat - a predictive microbiology approach

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Division of Seafood Research, FoodDTU, University of Bonn
Contributors: Møller, C., Kampmann, Y., Aabo, S., Christensen, B. B., Dalgaard, P., Hansen, T. B.
Publication date: 2010
Peer-reviewed: No
Event: Poster session presented at 8th Symposium on Food Microbiology, Helsingør, Denmark.
Source: orbit
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Research output: Contribution to conference › Poster – Annual report year: 2010 › Research

Effect of natural microflora on growth of Salmonella in fresh pork meat - a predictive microbiology approach

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Division of Seafood Research, FoodDTU, University of Bonn
Contributors: Møller, C., Kampmann, Y., Aabo, S., Christensen, B. B., Dalgaard, P., Hansen, T. B.
Publication date: 2010
Peer-reviewed: No
Event: Poster session presented at 2010 Symposium of The Danish Microbiological Society, KU-LIFE, Frederiksberg, Denmark.
Source: orbit
Source-ID: 272027
Research output: Contribution to conference › Poster – Annual report year: 2010 › Research

Effect of natural microflora on growth of Salmonella in fresh pork meat - a predictive microbiology approach

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Division of Seafood Research, FoodDTU, University of Bonn
Contributors: Møller, C., Kampmann, Y., Aabo, S., Christensen, B. B., Dalgaard, P., Hansen, T. B.
Number of pages: 32
Publication date: 2010

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Title of host publication: 2010 Symposium of the Danish Microbiological Society
Place of publication: Copenhagen, Denmark
Publisher: University of Copenhagen, Faculty of Life Sciences
Source: orbit
Source-ID: 272022
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 2010 › Research

Effect of natural microflora on growth of Salmonella in fresh pork meat - a predictive microbiology approach

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Division of Seafood Research, FoodDTU, University of Bonn
Contributors: Møller, C., Kampmann, Y., Aabo, S., Christensen, B. B., Dalgaard, P., Hansen, T. B.
Publication date: 2010
Peer-reviewed: No
Event: Poster session presented at 22nd International ICFMH Symposium, Copenhagen, Denmark.
Source: orbit
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Research output: Contribution to conference › Poster – Annual report year: 2010 › Research
Effect of natural microflora on growth of Salmonella in fresh pork meat - a predictive microbiology approach

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Division of Seafood Research, FoodDTU, University of Bonn
Contributors: Møller, C., Kampmann, Y., Aabo, S., Christensen, B. B., Dalgaard, P., Hansen, T. B.
Number of pages: 349
Publication date: 2010

Gaining more from pilot-plant studies: An example for VTEC in fermented semi-dried sausages

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Danish Technological Institute
Contributors: Hansen, T. B., Gunvig, A., Hansen, F., Aabo, S.
Number of pages: 349
Publication date: 2010

Growth of Salmonella in minced meat after freezing

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Birk, T., Hansen, T. B., Aabo, S.
Publication date: 2010
Peer-reviewed: No
Event: Poster session presented at 22nd International ICFMH Symposium, Copenhagen, Denmark.
Electronic versions: VTEC_poster260810.pdf
Source: orbit
Source-ID: 266763
Research output: Contribution to conference → Poster – Annual report year: 2010 → Research
Growth of Salmonella in minced meat after freezing

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Birk, T., Hansen, T. B., Aabo, S.
Number of pages: 349
Publication date: 2010

Host publication information
Title of host publication: 22nd International ICFMH Symposium, Food Micro 2010: Final programme & Abstract Book
Place of publication: Copenhagen, Denmark
Publisher: Kandrups Bogtrykkeri A/S
Source: orbit
Source-ID: 272030
Research output: Chapter in Book/Report/Conference proceeding → Conference abstract in proceedings – Annual report year: 2010 → Research

Influence of outer membrane virulence factors and the virulence plasmid (pYV) on the adhesion of Yersinia enterocolitica to pork skin and meat

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment
Contributors: Krag, R., Aabo, S.
Publication date: 2010
Peer-reviewed: Yes
Event: Poster session presented at International symposium on Yersinia, Recife, Brazil.
Source: orbit
Source-ID: 272172
Research output: Contribution to conference → Poster – Annual report year: 2010 → Research → peer-review

Influence of outer membrane virulence factors and virulence plasmid (pYV) for adhesion of Yersinia enterocolitica to pork

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment
Contributors: Krag, R., Aabo, S.
Publication date: 2010
Peer-reviewed: Yes
Event: Poster session presented at 8th Symposium on Food Microbiology, Helsingør, Denmark.
Source: orbit
Source-ID: 272166
Research output: Contribution to conference → Poster – Annual report year: 2010 → Research → peer-review

Salmonelaforekomsten i danske svin stiger

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Baggesen, D. L., Aabo, S., Hald, T.
Pages: 16-20
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Dyrlægemagasinet for Praktiserende Dyrlæger
Volume: 4
ISSN (Print): 1603-8002
Salmonella in pork cuttings in supermarkets and butchers' shops in Denmark in 2002 and 2006

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Christensen, B. B., Aabo, S.
Pages: 23-29
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Zoonoses and Public Health
Volume: 57
Issue number: 1
ISSN (Print): 1863-1959
Ratings:
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.857 SNIP 1.145
Web of Science (2010): Impact factor 2.22
Web of Science (2010): Indexed yes
Original language: English
DOIs: 10.1111/j.1863-2378.2010.01360.x

Survival and growth of exponential and stationary phase Salmonella in meat juice after freezing

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Birk, T., Aabo, S.
Publication date: 2010

Event information
Event: 8th Symposium on Food Microbiology
Location: LO-skolen, Helsingør, Denmark
Source: orbit
Source-ID: 269466
Research output: Contribution to journal > Conference article – Annual report year: 2010 > Research > peer-review

Survival and growth of exponential and stationary phase Salmonella in meat juice after freezing

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Birk, T., Hansen, T. B., Aabo, S.
Number of pages: 51
Publication date: 2010

Host publication information
Title of host publication: FMN - 8th Symposium on Food Microbiology
Publisher: LMC
Source: orbit
Source-ID: 263742
Research output: Chapter in Book/Report/Conference proceeding > Conference abstract in proceedings – Annual report year: 2010 > Research
The Community Summary Report on Trends and Sources of Zoonoses in 2008

General information
Publication status: Published
Organisations: Section of Fur Animal Diseases and Wildlife, Division of Poultry, Fish and Fur Animals, National Veterinary Institute, Division of Microbiology and Risk Assessment, National Food Institute
Contributors: EFSA Publication
Number of pages: 370
Publication date: 2010

Publication information
Publisher: European Food Safety Authority
Original language: English
(the EFSA Journal; No. 1496).
DOIs:
10.2903/j.efsa.2010.1496
URLs:
Source: orbit
Source-ID: 272150
Research output: Book/Report › Report – Annual report year: 2010 › Research › peer-review

Change in attachment of Yersinia enterocolitica to decontaminated pork meat

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Copenhagen
Contributors: Krag, R., Aabo, S., Olsen, J. E.
Number of pages: 24
Publication date: 2009

Host publication information
Title of host publication: 7th Symposium on Food Mircobiology
Source: orbit
Source-ID: 250774
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 2009 › Research

Change in surface attachment of pathogenic bacteria to decontaminated pork

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Copenhagen
Contributors: Krag, R., Aabo, S., Olsen, J. E.
Publication date: 2009
Peer-reviewed: No
Event: Poster session presented at 8th International Symposium, Epidemiology and Control of Foodborne Pathogens in Pork, Quémé City, Canada.
Source: orbit
Source-ID: 250771
Research output: Contribution to conference › Poster – Annual report year: 2009 › Research

Change in surface attachment of pathogenic bacteria to decontaminated pork

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Copenhagen
Contributors: Krag, R., Aabo, S., Olsen, J. E.
Pages: 313-317
Publication date: 2009
Changes in Salmonella prevalence in pork cuttings in supermarkets and butchers’ shops in Denmark from 2002 to 2006

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Christensen, B. B., Aabo, S.
Publication date: 2009
Number of pages: 411
Pages: 197-200
Publication date: 2009

Host publication information
Title of host publication: Proceedings 8th International Symposium, Epidemiology and Control of Foodborne Pathogens in Pork: September 30th to October 2nd 2009, Québec City, Québec, Canada
Place of publication: Québec, Canada
Publisher: Agricultural, Pêcheries et Alimentation; Université de Montréal
Source: orbit
Source-ID: 250757
Research output: Chapter in Book/Report/Conference proceeding – Article in proceedings – Annual report year: 2009 – Research

Comparison of Danish porcine and human isolates of Yersinia enterocolitica by PFGE profiling

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Statens Serum Institut
Contributors: Albrecht, J., Nielsen, E. M., Aabo, S.
Publication date: 2009
Peer-reviewed: No
Event: Poster session presented at 7th Symposium of Food Microbiology, Helsingør, Denmark.
Source: orbit
Source-ID: 245360
Research output: Contribution to conference – Poster – Annual report year: 2009 – Research

Comparison of Danish porcine and human isolates of Yersinia enterocolitica by PFGE profiling

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Statens Serum Institut
Contributors: Albrecht, J., Nielsen, E. M., Aabo, S.
Number of pages: 44
Consumption patterns and consumer risks: An overview of the Danish markets for pork, chicken and eggs and the consumer risk associated with Salmonella and Campylobacter

Effect of hot water and lactic acid decontamination on Escherichia coli, Salmonella Typhimurium and Yersinia enterocolitica on pork

Effect of hot water and lactic acid decontamination on Escherichia coli, Salmonella Typhimurium and Yersinia enterocolitica on pork
Predicting the Risk for Human Salmonellosis from Stochastic Modelling of Salmonella Carcass Contamination and Decontamination in Slaughter Pigs

*General information*
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Barfod, K., Sørensen, A. M. H., Wong, D. L., Aabo, S.
Publication date: 2009
Peer-reviewed: No
Event: Abstract from 12th Conference of the International Society for Veterinary Epidemiology and Economics, Durban, South Africa.

*Bibliographical note*
Can be found on the disc with conference contributions
Source: orbit
Source-ID: 250337
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2009 › Research

RNA extraction methods and separation of pathogenic bacteria in foods

*General information*
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Copenhagen
Contributors: Kjeldgaard, J., Henriksen, S., Cohn, M. T., Aabo, S., Ingmer, H.
Number of pages: 44
Publication date: 2009

*Host publication information*
Title of host publication: 7th Symposium on Food Microbiology : Abstracts
Place of publication: Copenhagen
Publisher: LMC
Source: orbit
Source-ID: 245369
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 2009 › Research

Evaluation of pathogen reduction obtained by decontamination of pig carcasses by steam-ultrasound (sonosteam®)

*General information*
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Christiansen, P., Sørensen, A. M. H., Andersen, R. K., Larsen, B. S., Aabo, S.
Publication date: 2008
Peer-reviewed: No
Event: Poster session presented at 21st International ICFMH Symposium, Aberdeen, United Kingdom.
Source: orbit
Source-ID: 233880
Research output: Contribution to conference › Poster – Annual report year: 2008 › Research
Evaluation of pathogen reduction obtained by decontamination of pig carcasses by steam-ultrasound (Sonosteam®)

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Christiansen, P., Sørensen, A. M. H., Krag, R., Larsen, B. S., Aabo, S.
Publication date: 2008
Peer-reviewed: No
Event: Abstract from 21st International ICFMH Symposium, Aberdeen, United Kingdom.
Source: orbit
Source-ID: 234730
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2008

Future progress in consumer safety of pork in Denmark may depend on carcass decontamination

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Aabo, S., Christiansen, P., Hansen, T. B., Krag, R., Sommer, H. M.
Publication date: 2008

Event information
Event: 21st International ICFMH Symposium
Location: Aberdeen, United Kingdom
Source: orbit
Source-ID: 234748
Research output: Non-textual form › Sound/Visual production (digital) – Annual report year: 2008

Future progress in consumer safety of pork in Denmark may depend on carcass decontamination

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Aabo, S., Christiansen, P., Hansen, T. B., Krag, R., Sommer, H. M.
Publication date: 2008
Peer-reviewed: No
Event: Abstract from 21st International ICFMH Symposium, Aberdeen, United Kingdom.
Source: orbit
Source-ID: 234268
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2008

Guidelines for regional food authorities to establish science based food safety programmes

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Aabo, S., Rosenquist, H., Christensen, B. B., Nielsen, N. L., Bondt, N., Wagenberg, C. V., Petersen, B.
Pages: 166-179
Publication date: 2008

Host publication information
Title of host publication: "from stable to table", Food Safety and Quality in International Food Chains : Technical Reports of the Interreg IIIC Initiative PromSTAP
Place of publication: Düsseldorf, Germany
Publisher: Ministry of the Environment and Nature Conservation, Agriculture and Consumer Protection of the State of North Rhine-Westphalia
ISBN (Print): 978-3-00-023664-8
Source: orbit
Source-ID: 234259
Research output: Chapter in Book/Report/Conference proceeding › Book chapter – Annual report year: 2008
peer-review
Innovative Systems in the field of food quality and safety

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Kreyenschmidt, J., Hansen, T. B., Kampmann, Y., Christensen, B. B., Aabo, S., Lettmann, T., Bruckner, S., Kostov, I., Beek, P. V., Petersen, B.
Pages: 152-165
Publication date: 2008

Host publication information
Title of host publication: "from stable to table", Food Safety and Quality in International Food Chains : Technical Reports of the Interreg IIIC Initiative PromSTAP
Place of publication: Düsseldorf, Germany
Publisher: Ministry of the Environment and Nature Conservation, Agriculture and Consumer Protection of the State of North Rhine-Westphalia
ISBN (Print): 978-3-00-023664-8
Source: orbit
Source-ID: 234257
peer-review

Is future progress in consumer safety of pork in Denmark dependent on carcass decontamination?

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Aabo, S., Barfod, K., Bohr, S. K., Christensen, T., Christiansen, P., Dejgaard, J., Hald, T., Krag, R., Mørkbak, M., Olsen, J. E., Sandøe, P., Sommer, H. M.
Publication date: 2008
Peer-reviewed: No
Event: Abstract from LMC 6th Symposium on Food Microbiology, Helsingør, Denmark.
Source: orbit
Source-ID: 234265
Research output: Contribution to conference – Conference abstract for conference – Annual report year: 2008 – Research

Modelling Salmonella Carcass Contamination and Decontamination in Slaughter Pigs

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Barfod, K., Aabo, S., Sørensen, A. M. H., Wong, D. L. F.
Publication date: 2008
Peer-reviewed: No
Event: Abstract from 21st International ICFMH Symposium, Aberdeen, United Kingdom.
Source: orbit
Source-ID: 233867
Research output: Contribution to conference – Conference abstract for conference – Annual report year: 2008 – Research

Modelling Salmonella Carcass contamination in slaughter pigs

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Barfod, K., Aabo, S., Sørensen, A. H., Wong, D. L. F.
Publication date: 2008
Peer-reviewed: No
Event: Abstract from 21st International ICFMH Symposium, Aberdeen, United Kingdom.
Source: orbit
Source-ID: 234279
Research output: Contribution to conference – Conference abstract for conference – Annual report year: 2008 – Research
Survival of Salmonella and physical response to cold storage of beef

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Aabo, S., Knudsen, G., Olsen, J. E.
Publication date: 2008
Peer-reviewed: No
Event: Abstract from 21st International ICFMH Symposium, Aberdeen, United Kingdom.
Source: orbit
Source-ID: 234277
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2008 › Research

Adaptation of Salmonella to low temperature and dessication

General information
Publication status: Published
Organisations: National Food Institute
Contributors: Knudsen, G., Aabo, S.
Publication date: 2007

Publication information
ISBN (Print): 978-87-7611-196-0
Original language: English
Source: orbit
Source-ID: 240269

A model to visualize attachment and survival of Yersinia enterocolitica in superficial and deep structures of pig carcasses before and after decontamination

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Copenhagen
Contributors: Krag, R., Olsen, J. E., Aabo, S.
Pages: 133-136
Publication date: 2007

Host publication information
Title of host publication: 7th International Symposium on epidemiology & control of foodborne pathogens in pork : SAFEPORK2007
Publisher: Padova, CLEUP Cooperativa Libraria Editrice Università di Padova Via Belzoni,
ISBN (Print): 978-88-6129-083-9
Source: orbit
Source-ID: 237770
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2007 › Research

A model to visualize attachment and survival of Yersinia enterocolitica in superficial and deep structures of pig carcasses before and after decontamination

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Krag, R., Olsen, J. E., Aabo, S.
Publication date: 2007
Peer-reviewed: No
Event: Poster session presented at 7th International Symposium on Epidemiology & Control of Foodborne Pathogens in Pork, Verona, Italy.
Source: orbit
Source-ID: 250376
Research output: Contribution to conference › Poster – Annual report year: 2007 › Research
Antimicrobial drug resistance of Salmonella isolates from meat and humans, Denmark

We compared 8,144 Salmonella isolates collected from meat imported to or produced in Denmark, as well as from Danish patients. Isolates from imported meat showed a higher rate of antimicrobial drug resistance, including multidrug resistance, than did isolates from domestic meat. Isolates from humans showed resistance rates lower than those found in imported meat but higher than in domestic meat. These findings indicate that programs for controlling resistant Salmonella spp. are a global issue.

Development of a "Decision Support Tool" (DST) for the pork supply chain

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Kreyenschmidt, J., Aabo, S., Bruckner, S., Christensen, B. B., Gkisakis, V., Hansen, T. B., Kampmann, Y., Lettmann, T., Raab, V., van Beek, P., Petersen, B.
Publication date: 2007
Peer-reviewed: No
Event: Poster session presented at 5th International Conference Predictive Modelling in Foods, Athens, Greece.

Host publication information
Title of host publication: Proceedings of the 5th International Conference Predictive modelling in Foods
Source: orbit
Source-ID: 247761
Research output: Contribution to conference – Poster – Annual report year: 2007 – Research
Development of a "Decision Support Tool" (DST) for the pork supply chain

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Kreyenschmidt, J., Aabo, S., Bruckner, S., Christensen, B. B., Gkisakis, V., Hansen, T. B., Kampmann, Y., Lettmann, T., Raab, V., Beek, P. V., Petersen, B.
Pages: 519-522
Publication date: 2007

Host publication information
Title of host publication: 5th International Conference Predictive modelling in Foods (IC PMF 2007), Fundamentals, State of the Art and New Horizons
ISBN (Print): 978-960-89313-7-4
Source: orbit
Source-ID: 237721
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2007 › Research

Performance evaluation of secondary models for prediction of growth rate of Salmonella in decontaminated fresh pork

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Kampmann, Y., Christensen, B. B., Aabo, S.
Pages: 313-316
Publication date: 2007

Host publication information
Title of host publication: 5th International Conference Predictive Modelling in Foods (IC PMF 2007), Fundamentals, State of the Art and New Horizons
ISBN (Print): 978-960-89313-7-4
Source: orbit
Source-ID: 237717
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2007 › Research

Performance evaluation of secondary models for prediction of growth rate of Salmonella in decontaminated fresh pork

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Kampmann, Y., Christensen, B. B., Aabo, S.
Publication date: 2007
Peer-reviewed: No
Source: orbit
Source-ID: 237725
Prevalence of Salmonella in minced pork meat in supermarkets and butchers' shops in Denmark and dependence on retail supply chains

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Department of Management Engineering
Contributors: Hansen, T. B., Shukri, N. M., Nielsen, N. L., Christensen, B. B., Aabo, S.
Publication date: 2007
Peer-reviewed: No
Event: Poster session presented at 7th International Symposium on Epidemiology & Control of Foodborne Pathogens in Pork, Verona, Italy.
Source: orbit
Source-ID: 239521
Research output: Contribution to conference › Poster – Annual report year: 2007 › Research

Quantification of Salmonella and Yersinia on pork carcasses by simulation modelling

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment
Contributors: Wong, D. L. F., Emborg, H., Sørensen, A. M. H., Sørensen, G., Aabo, S.
Pages: 133-136
Publication date: 2007
Peer-reviewed: No
Event: Poster session presented at 7th International Symposium on Epidemiology & Control of Foodborne Pathogens in Pork, Verona, Italy.
Source: orbit
Source-ID: 237766
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2007 › Research

A simulation model for the quantification of Salmonella spp. on swine carcasses

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment
Contributors: Wong, D. L. F., Sørensen, A. M. H., Sørensen, G., Tarp, C., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Event: Poster session presented at 11th International Society for Veterinary Epidemiology and Economics, Cairns, Australia.
Source: orbit
A simulation model for the quantification of Salmonella spp. on swine carcasses

General information
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment
Contributors: Wong, D. L. F., Sørensen, A. M. H., Sørensen, G., Tarp, C., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Source: orbit
Source-ID: 247964
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2006 › Research

Carcass contamination by Salmonella enterica, Yersinia enterocolitica, and E. coli in selected swine abattoirs in Denmark - data generation for control of control

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Sørensen, A. M. H., Sørensen, G., Christensen, H., Tarp, C., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Event: Poster session presented at 1st Annual Congress Promoting the stable to table approach, Genoa, Italy.
Source: orbit
Source-ID: 247921
Research output: Contribution to conference › Poster – Annual report year: 2006 › Research

Development of a "Decision Support Tool" using minced pork meat as a model

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Kreyenschmidt, J., Aabo, S., van Beek, P., Christensen, B. B., Kostov, L., Lettmann, T., Petersen, B., Stamminger, R.
Publication date: 2006
Peer-reviewed: No
Event: Poster session presented at The 2nd International Workshop on Opisthobranchia, Bonn, Germany.
Source: orbit
Source-ID: 247935
Research output: Contribution to conference › Poster – Annual report year: 2006 › Research

Development of guidelines for regional food authorities to establish science based food safety programs

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
First year of promotion of Codex approved microbiological Food Safety Management tools

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Christensen, B. B., Hansen, T. B., Andersen, J. K., Aabo, S., Boysen, L., Nørrung, B., Rosenquist, H., Nielsen, N. L.
Publication date: 2006
Peer-reviewed: No
Event: Abstract from 1st Annual Congress Promoting the stable to table approach, Genoa, Italy.
Source: orbit
Source-ID: 247915
Research output: Contribution to conference » Conference abstract for conference – Annual report year: 2006 » Research

Innovative systems in the field of food quality and safety. Development of a "Decision Support Tool" using minced pork meat as a model

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, University of Bonn, Wageningen University & Research
Contributors: Kreyenschmidt, J., Aabo, S., van Beek, P., Christensen, B. B., Hansen, T. B., Kampmann, Y., Kostov, L., Lettmann, T., Petersen, B.
Publication date: 2006
Peer-reviewed: No
Event: Abstract from 1st Annual Congress Promoting the stable to table approach, Genoa, Italy.
Source: orbit
Source-ID: 247985
Research output: Contribution to conference » Conference abstract for conference – Annual report year: 2006 » Research

Mapping retail suppliers of pork meat and prevalence of Salmonella in supermarkets and butchers' shops in Denmark

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Christensen, B. B., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Event: Poster session presented at 4th Symposium on Food Microbiology, Helsingør, Denmark.
Source: orbit
Source-ID: 247977
Research output: Contribution to conference » Poster – Annual report year: 2006 » Research

Mapping retail suppliers of pork meat and prevalence of Salmonella in supermarkets and butchers' shops in Denmark

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Christensen, B. B., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Event: Abstract from 4th Symposium on Food Microbiology, Helsingør, Denmark.
Source: orbit
Mapping retail suppliers of pork meat and prevalence of Salmonella in supermarkets and butchers' shops in Denmark

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Christensen, B. B., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Event: Poster session presented at 1st Annual Congress Promoting the stable to table approach, Genoa, Italy.
Source: orbit
Source-ID: 247932
Research output: Contribution to conference › Poster – Annual report year: 2006 › Research

Mapping retail suppliers of pork meat and prevalence of Salmonella in supermarkets and butchers' shops in Denmark

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Hansen, T. B., Christensen, B. B., Aabo, S.
Number of pages: 136
Pages: 107-111
Publication date: 2006

Host publication information
Title of host publication: Proceedings Cold Chain-Management : 2nd international Workshop, Bonn
Place of publication: Bonn
Publisher: Bonner Universitätsdruckerei
ISBN (Print): 978-3-00-018762-9
Source: orbit
Source-ID: 250374
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2006 › Research

Promotion of Codex approved microbiological food safety management tools

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Christensen, B. B., Hansen, T. B., Boysen, L., Rosenquist, H., Aabo, S., Andersen, J. K., Nørrung, B., Nielsen, N. L.
Publication date: 2006

Host publication information
Title of host publication: INTERREG IIIC RFO PromSTAP
Source: orbit
Source-ID: 243478
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2006 › Research

Risk Assessment of Salmonella in Pigs

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Aabo, S.
Number of pages: 371
Publication date: 2006

Host publication information
Title of host publication: Integrated Food Safety and Veterinary Public Health
SafeFood Guide: Development of guideline for regional food authorities to establish science based food safety programs

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Christensen, B. B., Hansen, T. B., Andersen, J. K., Aabo, S., Boysen, L., Rosenquist, H., Nielsen, N. L.
Publication date: 2006
Peer-reviewed: No
Event: Abstract from 1st Annual Congress Promoting the stable to table approach, Genoa, Italy.
Source: orbit
Source-ID: 247949
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2006 › Research

Salmonella enterica infected slaughter pigs and level of carcass contamination at selected abattoirs in Denmark

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Sørensen, A. M. H., Sørensen, G., Christensen, H., Tarp, C., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Source: orbit
Source-ID: 247954
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2006 › Research

Salmonella enterica infected slaughter pigs and level of carcass contamination at selected abattoirs in Denmark

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Sørensen, A. M. H., Sørensen, G., Christensen, H., Tarp, C., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Source: orbit
Source-ID: 247955
Research output: Contribution to conference › Poster – Annual report year: 2006 › Research

Salmonella in Pasteurised Egg

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Andersen, J. K., Perge, A., Aabo, S.
Publication date: 2006
Peer-reviewed: No
Event: Poster session presented at FoodMicro 2006, Bologna, Italy.
Source: orbit
Source-ID: 247904
Research output: Contribution to conference › Poster – Annual report year: 2006 › Research

Survival of Salmonella serovars on beef carcasses and molecular mechanisms to survive low temperature stress and desiccation

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
VTEC O157 subtypes associated with the most severe clinical symptoms in humans constitute a minor part of VTEC 0157 isolates from Danish Cattle

The aim of this study was to compare the distribution of VTEC O157 subtypes isolated from human sporadic infections with those in the Danish bovine reservoir, and to correlate the subtypes with the severity of the clinical symptoms in humans. The study included a total of 149 Danish eae-positive VTEC O157 isolates (63 of bovine origin and 86 from human clinical cases) isolated between 1987 and 2001. All were analysed by vtx-PCR-RFLP and phage typing. The vtx-PCR-RFLP showed that isolates carrying the vtx2 gene was more than four times as prevalent among the human clinical isolates (55%) as compared to the bovine isolates (13%). Furthermore, a significant correlation between the presence of the vtx2 gene and development of haemolytic-uraemic syndrome was found. The 149 isolates encompassed 16 different phage types (PTs). The majority (87%) of the human clinical isolates were identified, as PT2, PT4, PT8 or PT14 while only 46% of the bovine isolates belonged to these PTs. PT8 and PT14 were found at similar rates among bovine (36%) and human isolates (40%). However, the predominant PTs in the human isolates, PT2 (19%) and PT4 (28%), were only identified in 2% and 8%, respectively, of the bovine isolates. All but one PT2 and PT4 isolate carried either vtx2 alone or in combination with vtx2c, whereas none of the PT8 and PT14 isolates carried vtx2. The significant overlap between vtx/phage type combinations in bovine and human clinical isolates indicate that cattle are an important reservoir for human VTEC O157 infections in Denmark. However, the vtx2-carrying isolates, causing the most severe clinical symptoms, constitute only a minor fraction of the isolates from the Danish bovine reservoir.
Risk assessment of the impact on human health related to multiresistant Salmonella Typhimurium DT104 from slaughter pigs

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Number of pages: 105
Publication date: 2003

Publication information
Place of publication: Mørkhøj, Denmark
Publisher: Institute of Food Safety and Nutrition
Original language: English
Source-ID: 237009
Research output: Book/Report › Report – Annual report year: 2003 › Research

Sammenhæng mellem blodantistoffer og fækal udskillelse af S. Dublin hos slagtekalve: Technical Report, DVI 55034

General information
Publication status: Published
Organisations: Section for Veterinary Epidemiology and public sector consultancy, Division of Veterinary Diagnostics and Research, National Veterinary Institute, Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Bødker, R., Aabo, S.
Publication date: 2003

Publication information
Original language: Danish
Source-ID: 240709
Research output: Book/Report › Report – Annual report year: 2003 › Research

Quantitative comparison of intestinal invasion of zoonotic serotypes of Salmonella enterica in poultry

The aim of the present study was to compare the invasion of selected zoonotic Salmonella serotypes of poultry in an in vivo chicken intestinal loop model and also in vitro in epithelial cell cultures. Invasion was measured relative to a reference strain, Salmonella Typhimurium 4/74 invH201::TnphoA. Two serotypes demonstrated intracellular log(10) counts that differed significantly from all other serotypes tested: Salmonella Enteritidis PT4 being 1.5 log(10) colony forming units (CFU) (31-fold) higher, and Salmonella Tennessee being 0.7 log(10) CFU (fivefold) lower than the reference strain (P less than or equal to 0.0001). A group of serotypes, which can be vertically transmitted, showed significantly higher intracellular counts (fourfold to eightfold) than the reference strain. The group included S. Typhimurium 4/74, S. Typhimurium DT104 (poultry and porcine isolates), S. Enteritidis PT1, S. Enteritidis PT6, S. Enteritidis PT8, and Salmonella Berta. The serotypes Salmonella Hadar, Salmonella Virchow, S. 4,12: b:-, S. Typhimurium DT41, and Salmonella Infantis, most of which are considered horizontally transmitted, did not show significantly different intracellular counts from the reference strain. Results from the cell culture invasion studies agreed with the in vivo data, with the exception of S. Berta and the poultry isolate of S. Typhimurium DT104.

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Technical University of Denmark
Contributors: Aabo, S., Christensen, J., Chadfield, M., Carstensen, B., Olsen, J., Bisgaard, M.
Pages: 41-47
Publication date: 2002
Peer-reviewed: Yes

Publication information
Journal: Avian Pathology
Volume: 31
Issue number: 1
ISSN (Print): 0307-9457
Ratings:
Scopus rating (2002): SJR 0.789 SNIP 1.166
Comparative investigations of the invasion of Salmonella enterica in a chicken intestinal loop assay and cell culture assays

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Christensen, J. P., Aabo, S., Chadfield, M. S., Carstensen, B., Olsen, J. E., Bisgaard, M.
Publication date: 2001
Peer-reviewed: No
Event: Poster session presented at ASM 101st General Meeting, Orlando, FL, United States.
Source: orbit
Source-ID: 247376
Research output: Contribution to conference › Poster – Annual report year: 2001 › Research

Investigation into the host specific infection of the avian host by Salmonella serotype Gallinarum

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Olsen, J. E., Chadfield, M. S., Aabo, S., Christensen, J. P.
Publication date: 2001
Peer-reviewed: No
Event: Poster session presented at ASM 101st General Meeting, Orlando, FL, United States.
Source: orbit
Source-ID: 247429
Research output: Contribution to conference › Poster – Annual report year: 2001 › Research

Development of an in vivo model for study of intestinal invasion by Salmonella enterica in chickens
An in vivo loop test model for the investigation of the invasiveness of Salmonella enterica in chickens was developed. Ten jejunal loops were made in 10- to 12-week-old Lohman Brown chickens under isoflurana anaesthesia. Salmonella at 5.0 x 10(7) CFU was inoculated into each loop and left for 2 h, followed by a 1-h incubation with gentamicin in order to kill noninvading bacteria. After euthanasia, Salmonella invasiveness was measured as tissue-associated counts relative to a reference strain. The ability of Salmonella invasion was 1 log(10) CFU higher per 42-mm(2) mucosal tissue in the anterior than in the posterior part of jejunum. A statistically significant (P <0.001) sixfold difference in invasiveness was observed between a wild-type S. enterica serotype Typhimurium strain and the corresponding invH mutant. The model was shown to be able to show small differences in invasive capability and allows for comparison of strains tested in different animals, provided that the same reference strain is present in all animals.

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Section for Veterinary Diagnostics, Division of Veterinary Diagnostics and Research, National Veterinary Institute, Danish Veterinary Laboratory
Contributors: Aabo, S., Christensen, J., Chadfield, M., Carstensen, B., Jensen, T. K., Bisgaard, M., Olsen, J.
Pages: 7122-7125
Publication date: 2000
Peer-reviewed: Yes

Publication information
Journal: Infection and Immunity
Volume: 68
Issue number: 12
ISSN (Print): 0019-9567
Ratings:
Scopus rating (2000): SJR 2.137 SNIP 1.394
Web of Science (2000): Indexed yes
Original language: English
PCR-RFLP Analysis of Verocytotoxin genes of verocytotoxigenic E. coli (VTEC) isolated from Danish patients and cattle

**General information**
Publication status: Published
Organisations: National Food Institute, Division of Microbiology and Risk Assessment
Contributors: Roldgaard, B., Schultz, A. C., Aabo, S., Boel, J., Scheutz, F., Christensen, B. B.
Publication date: 2000
Peer-reviewed: No
Event: Abstract from 3rd Nordic Workshop on Viruses in Food and Water, Lillehammer, Norway.
Source: orbit
Source-ID: 239526
Research output: Contribution to conference » Conference abstract for conference – Annual report year: 2000 » Research

Virulence characterization of a strain of Salmonella enterica subspecies houten (subspecies IV) with chromosomal integrated Salmonella plasmid virulence (spv) genes

The Salmonella plasmid virulence genes (spv) are commonly found on plasmids contained in a small number of serotypes of Salmonella belonging to subspecies I, where they are important for survival within macrophages and the establishment of successful systemic infection. However, in this study, spv genes were detected by the polymerase chain reaction in the chromosome of a plasmid-free strain of S. IV 16:z(4), z(32):- (Salmonella subspecies IV). The full range of spv genes (spvR, spvA, spvB, spvC and spvD) was demonstrated, but a 216-bp deletion, accompanied by an insertion of 59-bp cryptic DNA, was present in spvA. S. IV 16:z(4), z(32):- was avirulent in mice and did not become virulent with the introduction of a fully functionally serotype-associated virulence plasmid (SAP) from S. typhimurium. By use of an spvRAB'-chloramphenicol acetyl transferase fusion gene, it was demonstrated that S. IV 16:z(4), z(32):- did not express the spv genes. Salmonella subspecies IV is monophasic, and in phylogenetic analyses it clusters distantly to Salmonella subspecies I, where all the serotypes that normally carry SAPs are found. The mechanisms by which spv genes have been transferred to this serotype remain unknown.

**General information**
Publication status: Published
Organisations: University of Copenhagen
Contributors: Aabo, S., Brown, D. J., Olsen, J. E.
VTEC O157 in cattle slaughtered in Denmark: correlation between presence in faecal samples and on warm and chilled carcasses

General information
Publication status: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute
Contributors: Boel, J., Tegtmeier, C., Thune-Stephensen, F., Roldgaard, B., Christensen, B. B., Aabo, S.
Number of pages: 215
Publication date: 2000

Host publication information
Title of host publication: 4th International Symposium on Shiga toxin (Vero-cytotoxin) - producing Escherichia coli infections: VTEC 2000
Place of publication: Kyoto, Japan
Publisher: VTEC 2000 Organizing Committees
Source-ID: 247353

Salmonella enteritidis infection in poultry: an emerging zoonosis in Zimbabwe

General information
Publication status: Published
Organisations: Communications and Management Secretariat, National Food Institute, Division of Microbiology and Risk Assessment
Contributors: Matope, G., Schlundt, J., Makaya, P. V., Aabo, S., Baggesen, D. L.
Pages: 132-138
Publication date: 1998
Peer-reviewed: Yes

Projects:

Microbiota Analyses for Disclosing Potential Pathogen Growth in Food
Buschhardt, T., PhD Student, National Food Institute
Aabo, S., Main Supervisor
Bacterial response to stress by biocides
Seier-Petersen, M. A., PhD Student, National Food Institute
Aarestrup, F. M., Main Supervisor
Agersø, Y., Supervisor
Ussery, D., Supervisor
Aabo, S., Examiner
Guardabassi, L., Examiner
Webber, M., Examiner
Forskningsrådsfinansiering
01/12/2009 → 18/09/2013
Award relations: Bacterial response to stress by biocides
Project: PhD

Microbiological and molecular characterization of successful salmonella
Müller, A. K., PhD Student, National Food Institute
Agerse, Y., Main Supervisor
Aabo, S., Supervisor
Aarestrup, F. M., Supervisor
Pedersen, K., Examiner
Olsen, J. E., Examiner
McDermott, P. F., Examiner
Offentlig finansiering
01/12/2008 → 23/05/2012
Award relations: Microbiological and molecular characterization of successful salmonella
Project: PhD

Use of next-generation sequencing and meta-genomics for detection, identification, characterization and molecular epidemiology of primarily foodborne virus
Hjelmsøe, M. H., PhD Student, National Food Institute
Aarestrup, F. M., Main Supervisor
Lund, O., Supervisor
Schultz, A. C., Supervisor
Aabo, S., Examiner
Kalsen Fischer, T., Examiner
Koopmans, M. P. G., Examiner
Samfinansieret - Andet
15/12/2013 → 05/12/2017
Award relations: Use of next-generation sequencing and meta-genomics for detection, identification, characterization and molecular epidemiology of primarily foodborne virus
Project: PhD

Foodenvironmental impact on the infectivity of salmonella
Henriksen, S., PhD Student, National Food Institute
Aabo, S., Main Supervisor
Josefsen, M. H., Examiner
Axelsson, L., Examiner
Olsen, J. E., Examiner
Programbevilling
01/08/2008 → 07/05/2014
Award relations: Foodenvironmental impact on the infectivity of salmonella
Project: PhD
Risk based control in pig slaughter
Bollerslev, A. M., PhD Student, National Food Institute
Aabo, S., Main Supervisor
Hald, T., Supervisor
Hansen, T. B., Supervisor
Nauta, M., Supervisor
Pamp, S. J., Examiner
Alban, L., Examiner
Zutter, L. D., Examiner
Technical University of Denmark
01/09/2012 → 30/09/2017
Award relations: Risk based control in pig slaughter
Project: PhD

Prebiotics for Prevention of Salmonella Infections
Petersen, A., PhD Student, National Food Institute
Licht, T. R., Main Supervisor
Poulsen, M., Supervisor
Aabo, S., Examiner
Kleerebezem, M., Examiner
Forskningsrådsfinansiering
01/04/2007 → 25/08/2010
Award relations: Prebiotics for Prevention of Salmonella Infections
Project: PhD

The interpretation of quantitative microbiology data: meeting the demands of quantitative microbiological risk assessment
Ribeiro Duarte, A. S., PhD Student, National Food Institute
Nauta, M., Main Supervisor
Aabo, S., Supervisor
Vigre, H., Supervisor
Dalgaard, P., Examiner
Evers, E., Examiner
Nørrung, B., Examiner
1/3 FUU, 1/3 inst 1/3 Andet
01/03/2010 → 18/09/2013
Award relations: The interpretation of quantitative microbiology data: meeting the demands of quantitative microbiological risk assessment
Project: PhD

Modelling of pathogen survival in fermented products
"Control of foodborne infections from lightly preserved meat products through mathematical modelling and efficient HACCP-based control programmes". Acronym: Confood.
HACCP-based control programs are mandatory and are implemented by most enterprises but very often these have shown to be inefficient in ensuring inactivation of VTEC and Salmonella. The aim of the project is to generate data and develop mathematical models, which predict the reduction of Salmonella and verocytotoxigenic E. coli (VTEC) at different process and product conditions.
A web-based user-friendly tool will be developed, which will enable industry to assess their current recipes and processes and to develop new and safe products. In addition we will investigate for factors during processing, which are of possible importance for infectivity of VTEC and Salmonella. E.g gene expression studies will be included.
Project financing
The Danish Strategic Research Council.
The project was granted 9.5 mill dkr., which is approximately 90% of the project costs. The remaining was supplied by the Danish Meat Research Institute.
aabo, S., Project Manager, National Food Institute, Division of Food Microbiology
Hansen, T. B., Contact Person, National Food Institute, Division of Food Microbiology
01/01/2008 → 01/06/2012
Collaborators: Statens Serum Institut, University of Copenhagen, Danish Meat Research Institute
Project: Research

Infektion STm DT41: Infektionsevnen af Salmonella Typhimurium DT41 i rugeægshøner og slagtekyllinger
Aabo, S., Project Manager, National Food Institute, Division of Food Microbiology
Nordentoft, S., Project Participant, National Food Institute, Division of Food Microbiology
PassPork: PassPork: A multi-pathogen pre-screening tool for safer pork products

Within the European meat sector, pork is the most produced and consumed meat as well as the most exported. However, pork is also responsible for a high number of verified outbreaks per year, with Salmonella, Yersinia, Listeria and Campylobacter representing practically all verified pork-associated infections in the EU in recent years.

While large enterprises in the pork industry may be able to afford the regular application of expensive tests; for SMEs, which account for 94% of businesses in the European meat industry, these methods are mostly beyond economic reach, thus impeding their capability to comply with strict regulations.

The main objective is to develop, validate and test an affordable, robust, rapid and reliable multi-pathogen detector for use by non-technical staff in the pork industry.

The device will build upon a combination of immuno-chromatography, fluorescence labelling and optical scanner technologies, together with specific monoclonal antibodies, which will reach detection limit in the range of 10-100cfu/ml.

The manner in which meat samples are collected and pre-treated has great effect over the accuracy of any subsequent test for the presence and count of pathogens. DTUs role is to identify the most effective sampling method and to design sample collection and preparation protocols to be applied in field conditions.

DTU will also be part of the in-field demonstrations of the final prototype which are conducted to collect end-user feedback and recommendations.

SafeOrganic: SafeOrganic: Restrictive use of antibiotics in organic animal farming – a potential for safer, high quality products with less antibiotic resistant bacteria

Spread of antibiotic resistance along the food-chain is a major food safety concern due to the risk of treatment failure of human foodborne infections. Recent reports suggest that the restrictions on use of antibiotics in organic animal farming promote lower levels of antibiotic resistance in organic animal products as compared to conventional products. This is, however, scarcely documented in the EU, particularly for swine. Thus, the organic pig production is probably characterized by significant lower levels of antibiotic resistance and providing the documentation of this very important quality parameter of organic pigs holds the opportunity of exploiting this essential advantage of organic pork in marketing. Therefore, in SafeOrganic it will be documented whether the organic pigs in different European countries does show lower levels of antibiotic resistant bacteria compared to the conventional pigs. Furthermore, there seems to be a widespread routine of slaughtering conventional and organic animals at the same slaughter lines without special hygiene barriers to avoid cross-contamination. An important part of the project is therefore to investigate to which degree antibiotic resistant bacteria from conventional raised animals is transferred to organic meat during processing. Accordingly, SafeOrganic will assess and suggest management options, which can minimize the contact and hence risk of cross-contamination between the organic and the conventional meat products during slaughter. Information on the antibiotic use at farm level is normally not available, which hampers the authority control of imprudent use of antibiotics. Therefore, SafeOrganic will investigate if bacterial antibiotic resistance patterns and genotypes can be used as markers for the consumption of antibiotics in organic animal production. The results obtained in the project will be communicated to end-users enabling the slaughter industry to reduce spread of antibiotic resistant bacteria, and organic animal farmers to market pork meat with very low levels of
antibiotic resistant bacteria implying an improved food safety quality compared to pork from conventional farming systems.

Jensen, A. N., Project Participant, National Food Institute, Division of Food Microbiology
Aabo, S., Project Manager, National Food Institute, Division of Food Microbiology

FP7 Contract ID: CORE Organic II ERA-net
01/11/2011 → 31/10/2014

Collaborators: National Veterinary Institute, Veterinary Research Institute, University of Copenhagen, Instituto Zooprofilattico Sperimentale delle Venezie, ANSES - French Agency for Food, Environmental and Occupational Health & Safety

Documents:
Leaflet_SafeOrganic_2012
SafeOrganic leaflet 2014

Project: Research

Meat-Cross-Con: Meat safety - An innovative modelling approach to evaluate microbial pathogen transfer and cross contamination from farm to fork

Spread of pathogens in the meat chain constitutes a major food safety concern as enteropathogens in animals brought to slaughter contaminate process equipment and carcass surfaces, and cross contaminate non-contaminated meat in the meat processing line. Also, temperatures can exceed cooling chain demands and cause growth of pathogens. To adjust processes and to perform adequate cleaning regimens in the most effective way, the industry needs tools that enable them to identify the critical handling procedures and process equipment. We therefore aim to develop novel bacterial cross contamination models for the slaughter process (pigs) and the handling of selected meat products (beef). We combine laboratory experiments and field studies to explore the magnitude and the nature of cross contamination. We hypothesize that it is possible to quantify cross contamination of meat conferred by specific processes or equipment. This will be done by studying 1) transfer of Salmonella and Listeria monocytogenes between meat samples and between meat and equipment 2) the changes in the microbial population (microbiota) on carcasses and on meat products passing specific process steps. The latter approach is an extension of microbiota analysis used for source tracking. We also hypothesize that a microbiota analysis will be able to reflect whether bacterial growth has taken place. 16S-RNA gene pyrosequencing will be used for the study of systematic changes microbiota. The collaboration between Brazil and Denmark has the potential to significantly impact hygiene intervention, and support a harmonised quality assurance and risk management by industry and public authorities in the two countries and internationally.

Aabo, S., Project Manager, National Food Institute, Division of Microbiology and Risk Assessment

01/04/2005 → 31/12/2009

Collaborators: University of Copenhagen, Danish Technological Institute

Efficacy, cost benefit, and consumer perception of post harvest pathogen reduction of fresh pork

The project aimed to provide a firm scientific basis for decision-making is mandatory for general acceptance of post harvest decontamination. The project was structured in five work-packages, which combined natural science, social science and economical science. The project examined the ability of decontamination methods to eliminate pathogens in superficial and deep structures of pig carcasses. A model was developed, which estimated the quantitative burden of enteropathogens on pig carcasses. This model formed the basis of a quantitative risk assessment of decontamination of pig carcasses on the consumer risk. Consumer acceptance of decontamination was also be investigated. This work included an interview based investigation of consumer perception of decontamination of fresh meat, in particular pork meat, including the perception of safety and quality pork and food in general. The interview will also display the willingness of the consumer to pay for the increased food safety. An economical analysis of the cost-efficiency of decontamination, and a study of the consumer willingness to pay was included.

Aabo, S., Project Manager, National Food Institute, Division of Microbiology and Risk Assessment

01/04/2005 → 31/12/2009

Collaborators: University of Copenhagen, Danish Technological Institute
Control of foodborne infections from lightly preserved meat products through mathematical modelling and efficient HACCP-based control programmes (CONFOOD)

HACCP-based control programs are mandatory and are implemented by most enterprises but very often these have shown to be inefficient in ensuring inactivation of VTEC and Salmonella. The aim of the project is to generate data and develop mathematical models, which predict the reduction of Salmonella and verocytotoxigenic E. coli (VTEC) at different process and product conditions. A web-based user-friendly tool will be developed, which will enable industry to assess their current recipes and processes and to develop new and safe products. In addition we will investigate for factors during processing, which are of possible importance for infectivity of VTEC and Salmonella. E.g gene expression studies will be included.

Aabo, S., Project Manager, National Food Institute, Division of Microbiology and Risk Assessment
01/01/2008 → 31/12/2011

Collaborators: Statens Serum Institut, University of Copenhagen, Danish Technological Institute

Project: Research

Activities:

Organising committee Institute Network "Microbial Modelling, Epidemiology and Risk Assessment"
Period: 2017 → 2020
Maarten Nauta (Other)
Paw Dalgaard (Other)
Søren Aabo (Other)
Johanne Ellis-Iversen (Other)
National Food Institute
Research group for Risk Benefit
Research group for Food Microbiology and Hygiene
Group for Epidemiological Risk Assessment
Division of Risk Assessment and Nutrition

Description
Organise cross divisional lunch meetings every 3 months
Documents:
overview of meetings

Related organisation

Organising committee Institute Network "Microbial Modelling, Epidemiology and Risk Assessment"
Maarten Nauta (Other), Paw Dalgaard (Other), Søren Aabo (Other), Johanne Ellis-Iversen (Other)
2017 → 2020
Keywords: microbiology, model, Epidemiology
Activity: Other
4th International Workshop Cold Chain Management (CCM 2010)
Period: 27 Sep 2010 → 28 Sep 2010
Søren Aabo (Participant)
National Food Institute
Division of Microbiology and Risk Assessment

Related event
4th International Workshop Cold Chain Management (CCM 2010)
27/09/2010 → 28/09/2010
Bonn, Germany
Activity: Attending an event › Participating in or organising a conference

8th Symposium on Food Microbiology
Period: 2 Jun 2010 → 3 Jun 2010
Søren Aabo (Participant)
National Food Institute
Division of Microbiology and Risk Assessment

Related event
8th Symposium on Food Microbiology
02/06/2010 → 03/06/2010
Helsingør, Denmark
Activity: Attending an event › Participating in or organising a conference

Nytår, Netværk og National Funding
Period: 7 Jan 2010 → 8 Jan 2010
Søren Aabo (Participant)
National Food Institute
Division of Microbiology and Risk Assessment

Related event
Nytår, Netværk og National Funding: LMC Workshop
07/01/2010 → 08/01/2010
Slagelse, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Future progress in consumer safety of pork in Denmark may depend on carcass decontamination
Period: 4 Sep 2008
Søren Aabo (Speaker)
National Food Institute
Division of Microbiology and Risk Assessment

Description
Place: FOOD MICRO 2008, Aberdeen, Scotland

Related external organisation
Unknown Organization
Activity: Talks and presentations › Conference presentations
Is future progress in consumer safety of pork in Denmark dependent on carcass decontamination?
Period: 8 May 2008
Søren Aabo (Speaker)
National Food Institute
Division of Microbiology and Risk Assessment

Description
Place: LMC Foodmicro08, Helsingør, Denmark

Related external organisation
Unknown Organization
Activity: Talks and presentations › Conference presentations

Innovative systems in the field of food quality and safety. Development of a "Decision Support Tool" using minced pork meat as a model
Søren Aabo (Speaker)
National Food Institute
Division of Microbiology and Risk Assessment

Description
Place: PromSTAP, First Annual Congress, Genoa

Related external organisation
Unknown Organization
Activity: Talks and presentations › Conference presentations

Survival of Salmonella serovars on beef carcasses and molecular mechanisms to survive low temperature stress and desiccation
Period: 10 May 2006 → 12 May 2006
Søren Aabo (Speaker)
National Food Institute
Division of Microbiology and Risk Assessment

Description
Place: I3S International Symposium Salmonella and Salmonellosis, Saint-Malo, France

Related external organisation
Unknown Organization
Activity: Talks and presentations › Conference presentations

Press clippings:

Salmonella Enteritidis PT 21 i æg
Søren Aabo
22/08/2014

Subject
Salmonella Enteritidis PT 21 i æg
National Food Institute, Division of Food Microbiology

Media contribution (1)
Salmonella Enteritidis PT 21 i æg