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Quantitative risk assessment of campylobacter via broiler chicken in Germany

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Introduction

Campylobacteriosis is an important human health issue in developed countries where contaminated broiler chicken meat is assumed to be the major source of human infection. This disease is responsible for economic and life quality losses in infected humans. Current control strategies are mainly based on biosecurity measures at the farm level and HACCP measures at slaughterhouses. These measures are not sufficient to effectively control the disease in humans.

Material and methods

- from farm to fork model: with a modular structure (Fig. 1)
- mechanistic, stochastic and individual based model

Figure 1: from farm to fork modules represented in the model

Farm module

- Flock of 20,000 animals reared for 45 days
- Day of disease introduction in the flock: estimated from field data (UK)
- Two phases of disease spread in a flock:
  - phase of fast transmission within a cluster of animals in the first 5 days
  - Phase of epidemic spread represented using an SI epidemic model

Processing module

- Sequential slaughtering of flocks and carcasses in a random order
- 5 processing steps accounted for: scalding, defeathering, evisceration, washing and chilling
- At each processing step: (calibration based on field data)
  - Exchange of bacteria between the carcass and the processing step environment (Fig. 2)
  - Auto contamination of carcasses due to faeces leakage
  - Inactivation and removal of bacteria from the carcass and the environment

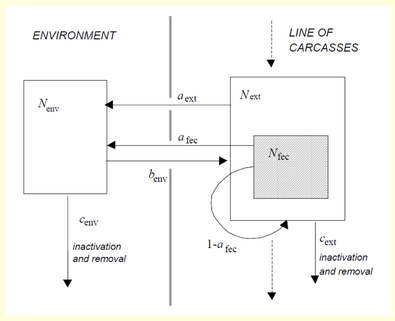


Figure 2: Bacterial dynamics at each slaughtering step (from Nauta et al. 2005)

Transformation & storage module:

- Cutting of a proportion of the produced carcasses: breast fillets & legs
- Bacterial survival and cross contamination due to manipulation
- Refrigeration or freezing of carcasses and chicken pieces:
  - Decrease of level of contamination (bacteria inactivation)
  - Decrease in prevalence of contaminated carcasses

Food preparation module:

- Households buy meat after storage at the retail
- Household structure bases on German data: adults and kids
- Human exposure pathways:
  - Cross contamination of other not cooked food by the meat
  - Risk of meat undercooking: bacterial survival to cooking

Human response module: Fig. 3

- Dose response model: beta–poisson model (experimental data Black et al., 1988)
- Population sensitivity: 20% of the German population is assumed to be resistant to campylobacter

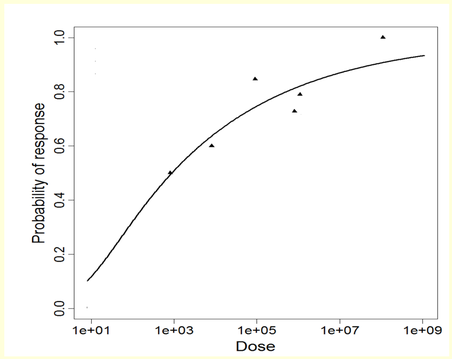


Figure 3: human dose response model for campylobacter

Objectives

- Quantitative risk assessment of campylobacter via broiler meat in Germany

Results & Discussion

- An average flock prevalence of 45.6% (Fig. 4)
- In infected flocks almost all animals are infected (Fig. 4)

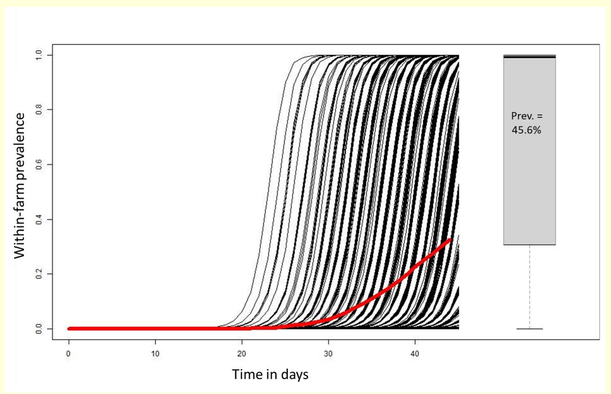
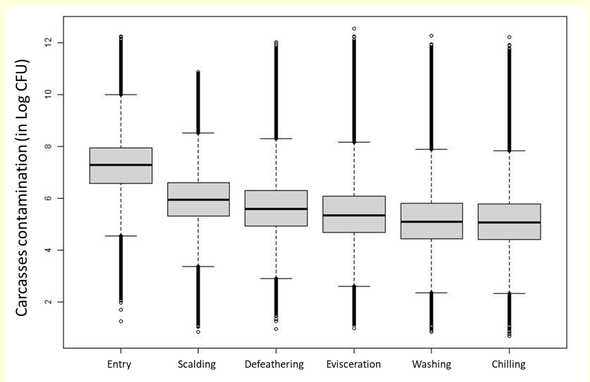


Figure 4: Within flock dynamics of campylobacter (3000 runs)



- In contaminated flocks, the slaughtering allowed a decrease in level of carcasses contamination of about 2 log CFU (Fig. 5)
- During slaughtering, 0.96% of the initially non infected carcasses have been cross contaminated

Figure 5: level of contamination of initially infected carcasses at different slaughtering steps

- The storage of carcasses and meat pieces didn‘t allow a significant decrease in the level of meat contamination in contaminated meat but led to a decrease in prevalence of contaminated meat (Fig. 6)

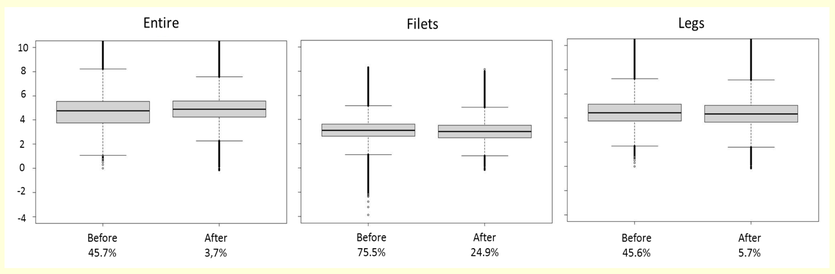


Figure 6: prevalence and level of contamination of broiler meat before and after storage

- the estimated annual incidence was 911 cases/100 000 inhabitants (Fig. 7)
- Compared to reported cases in 2018 (81 cases per 100 000): a reporting rate of 1/11

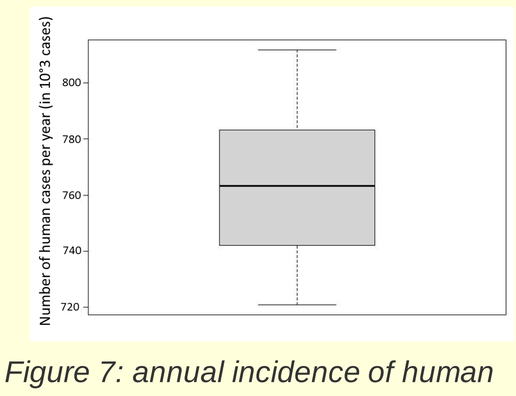


Figure 7: annual incidence of human campylobacter

Conclusion

- Within-flock disease transmission: need for an initial fast transmission in a cluster of animals
- Processing: decrease in carcasses contamination level & increase in prevalence
- Storage: non significant decrease in contamination levels & decrease in prevalence
- Ratio between declared and simulated cases (≈ 1/11)
- Next step: use the model to assess the effectiveness of control strategies

ONE HEALTH APPROACH CAMPYLOBACTER
Preventing and Combating Infections

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