

# Hygiene and *Salmonella* contamination of pork at slaughter

## *Preparation for a risk based statistical process control*

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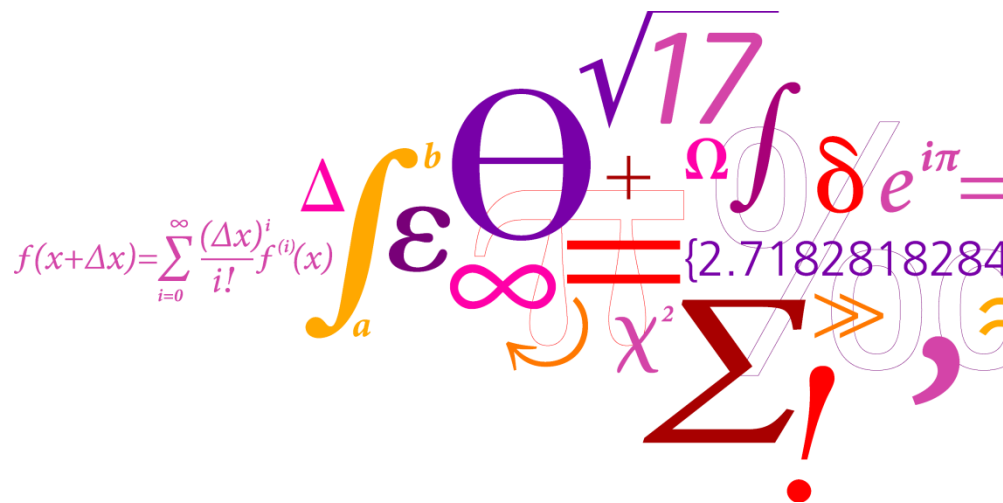
The National Food Institute

Technical University, Denmark

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DTU Fødevareinstituttet

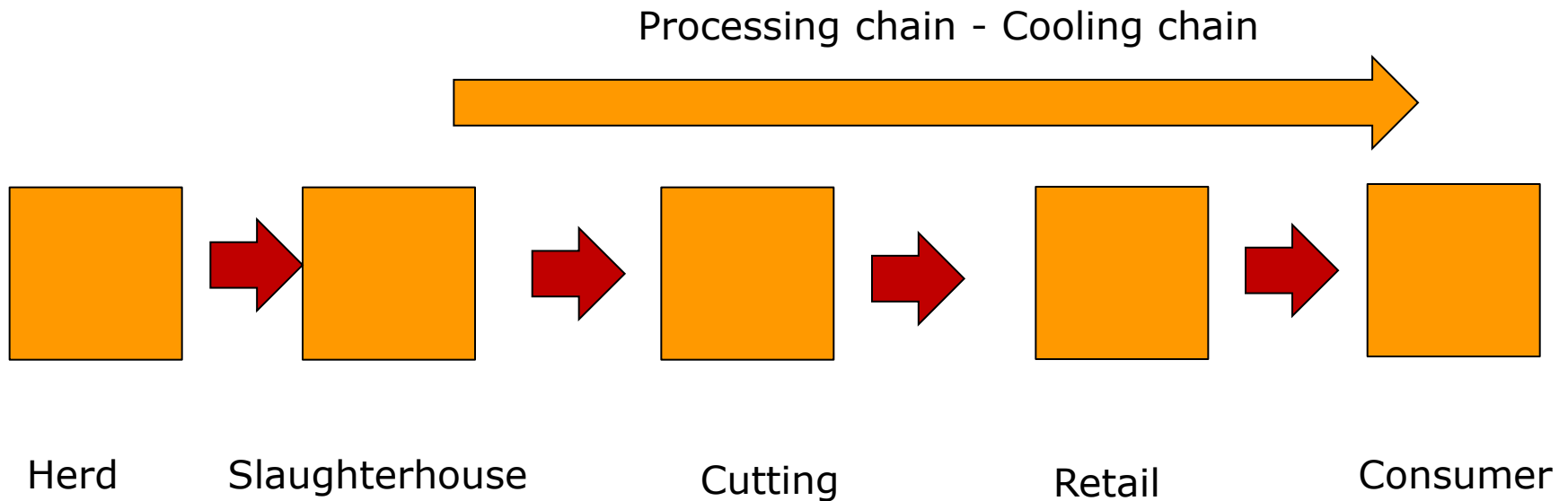
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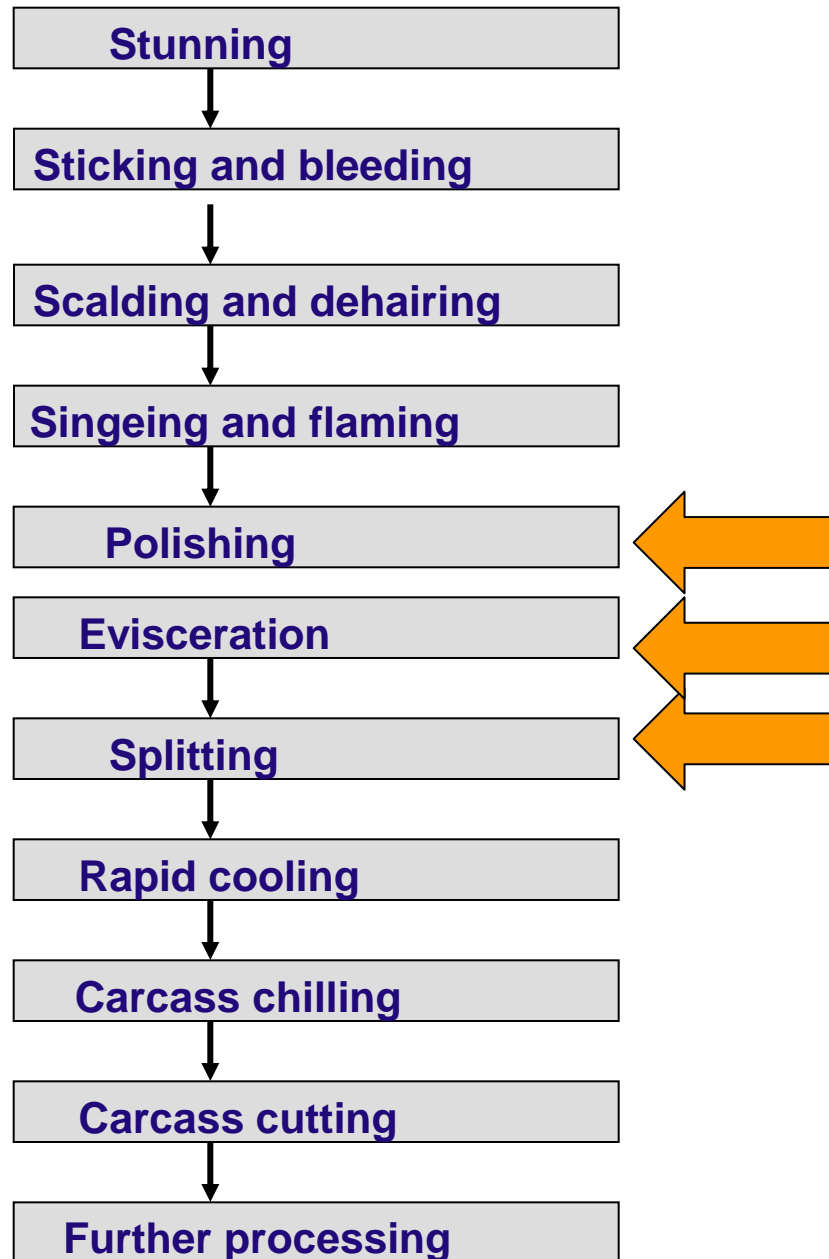
# Introduction 1

- Slaughter inevitably a dirty process
- Enteropathogens (*Salmonella* / *Yersinia*) spread from faeces to the carcass
- Also spoilage bacteria contaminate meat at slaughter
- Recent reports point at equipment as responsible for high contamination rather than direct faecal spread between animals/carcasses
- Slaughterhouses monitor *Salmonella* but intervene on hygiene (*E. coli* / Enterobacteriaceae).
- A statistical process control has to combine both probability and the magnitude of *Salmonella* contamination and be based on an indicator.

# Does slaughter process hygiene indicators as *E. coli* link to Salmonella consumer risk?



# Contamination in slaughter line processes



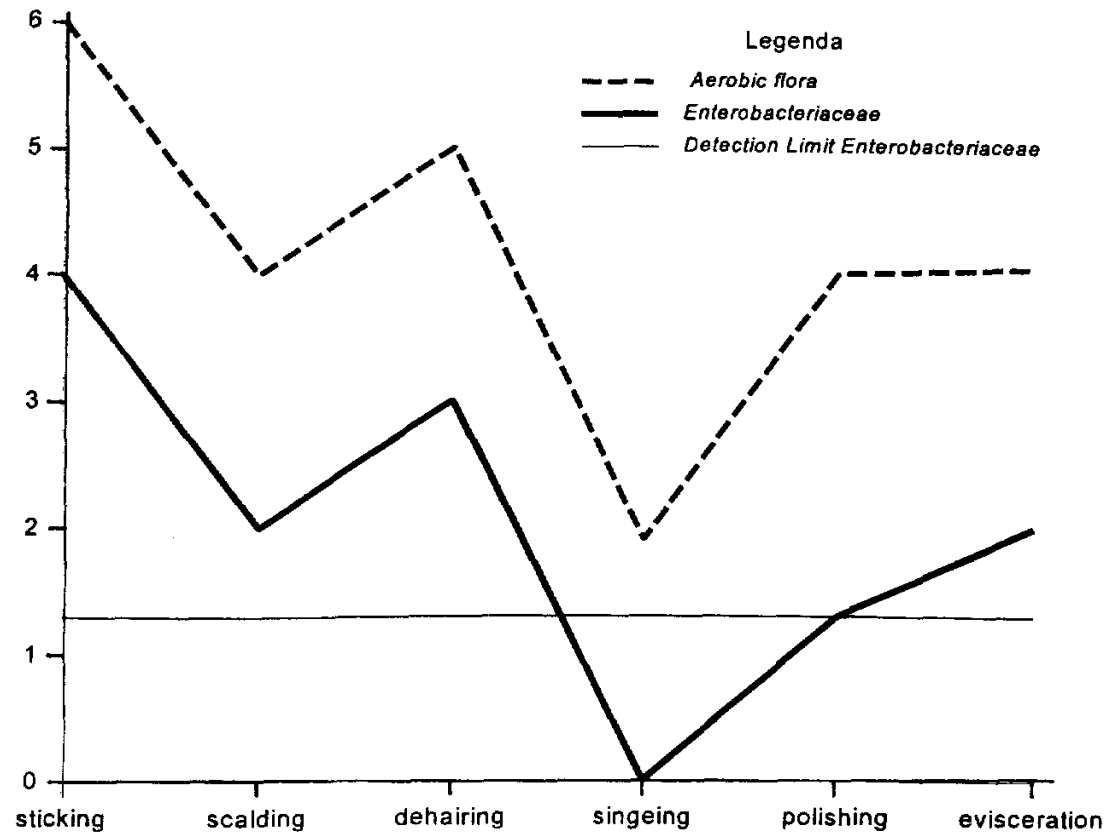
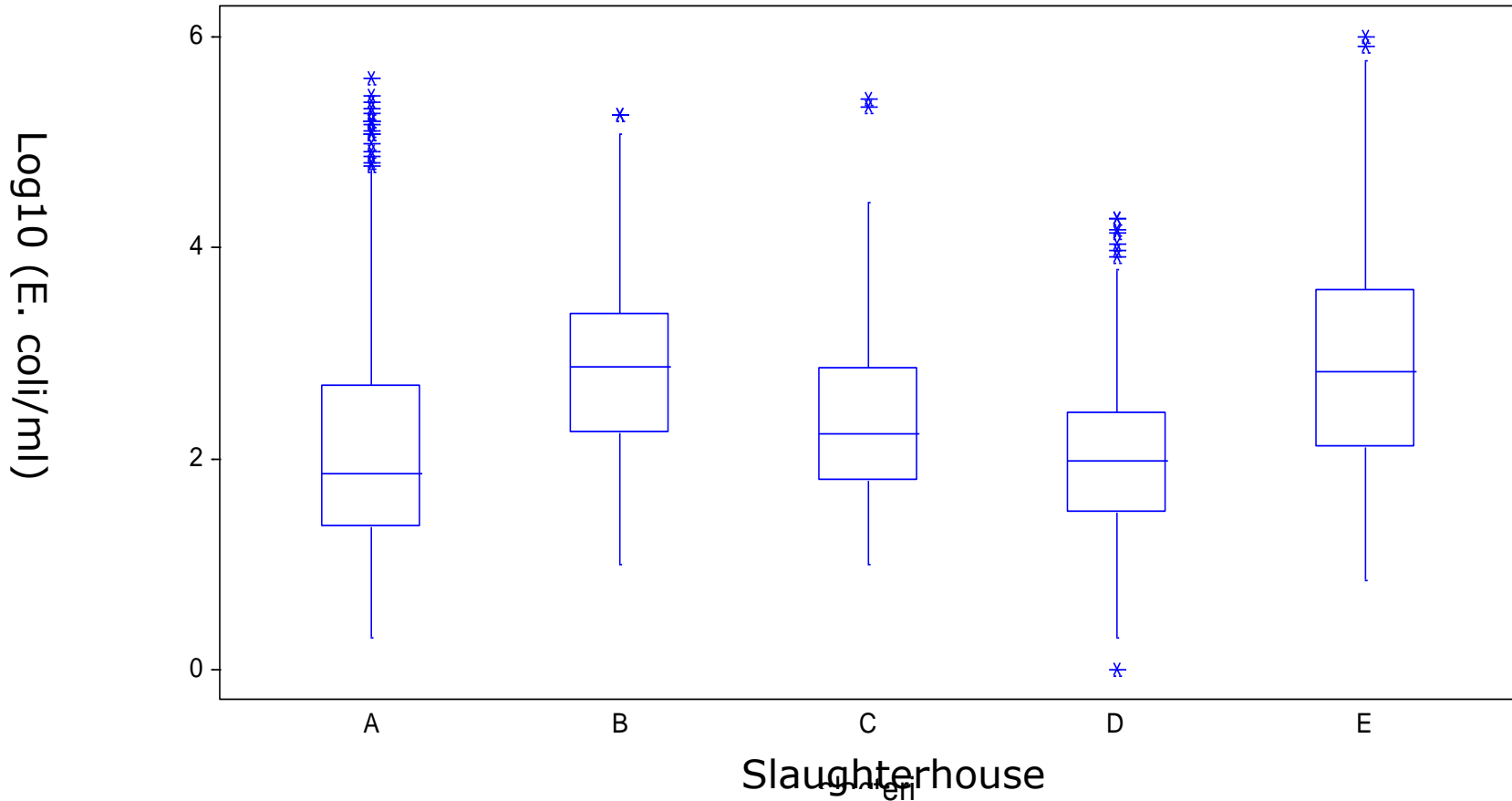


Fig. 1. Changes in colony forming units ( $\log_{10}$ )/ $\text{cm}^2$  of aerobic flora and *Enterobacteriaceae* on the skin of pigs in Dutch (Gerats, 1990).

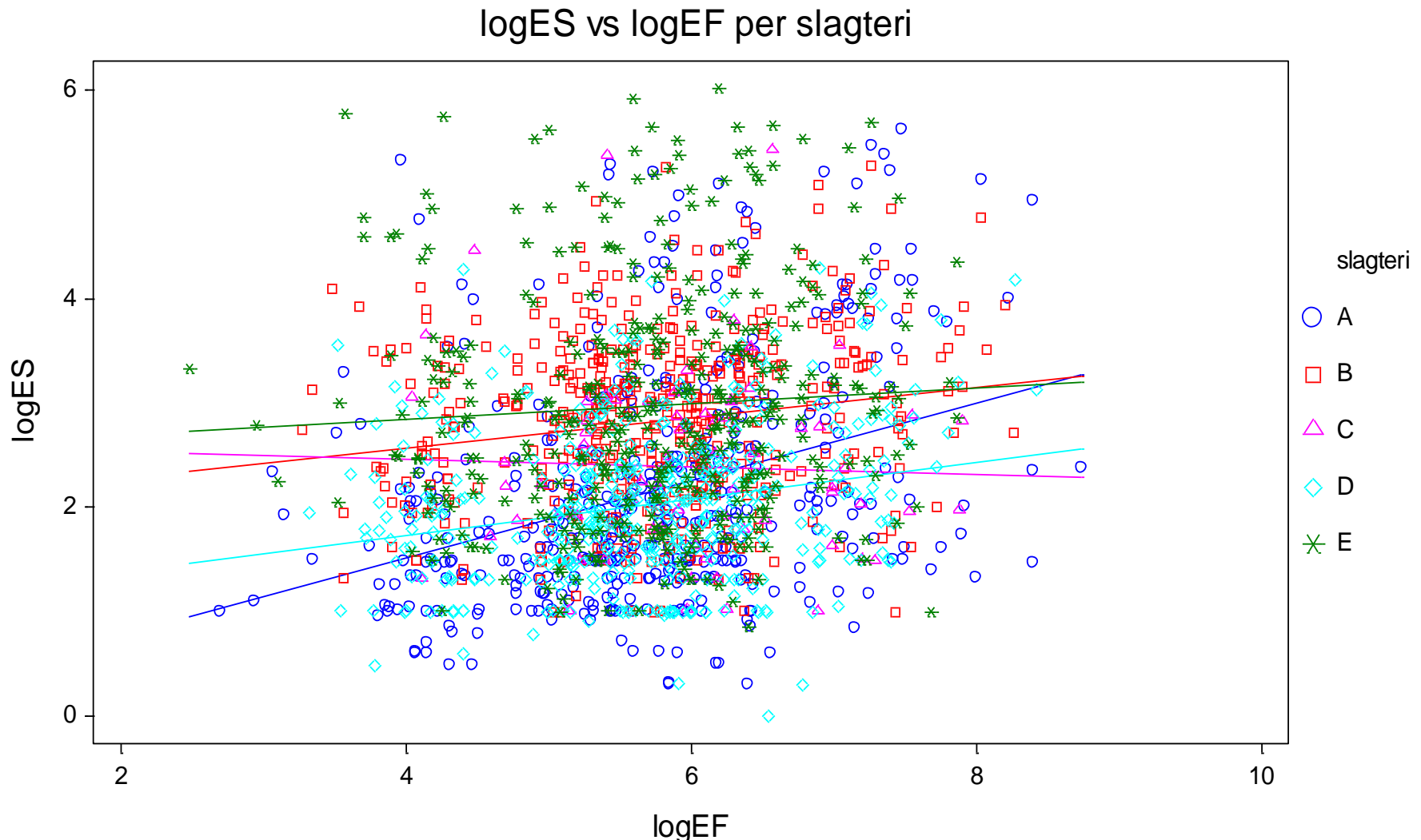
# E.coli carcass contamination in 5 Danish pig slaughterhouses

Box and Whisker Plot

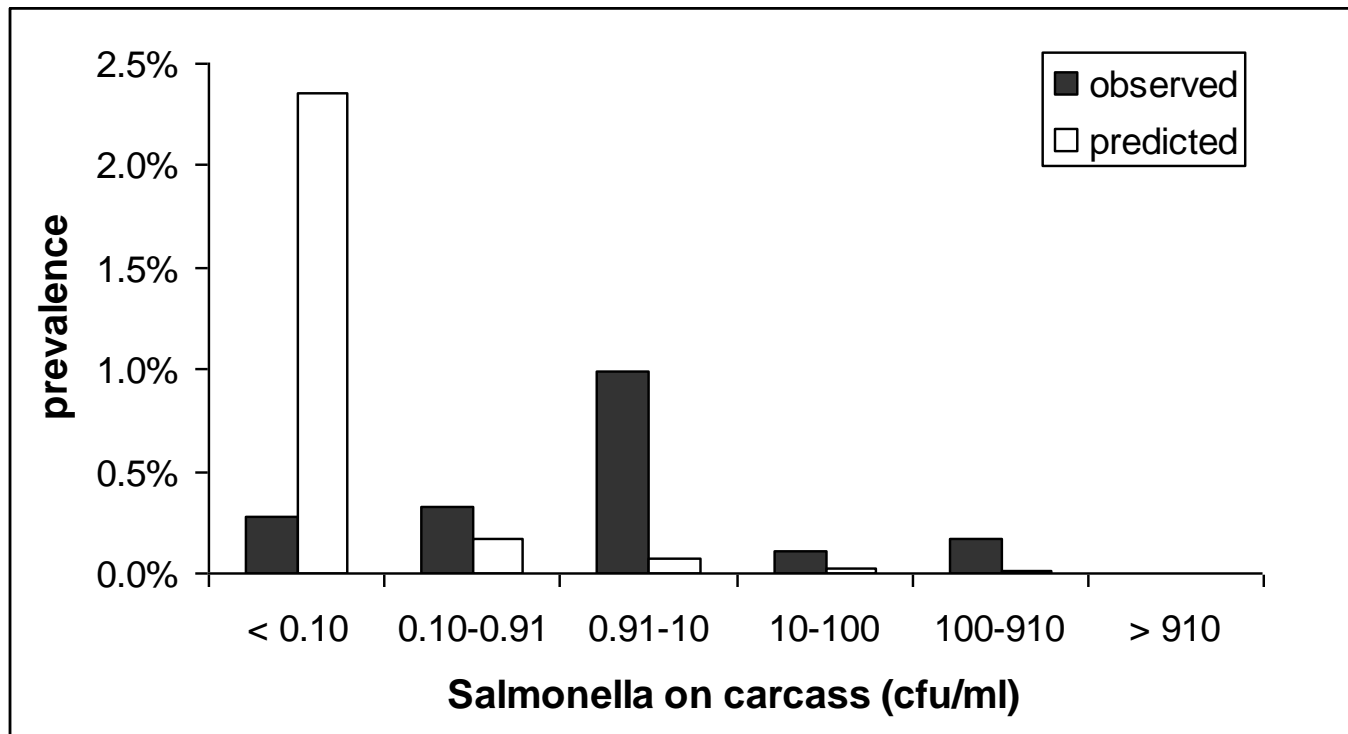


1798 cases 1082 missing cases

# Relationship between *E. coli* in feces and *E. coli* on carcass at slaughter (in individual animals)



# Quantitative predicted and observed *Salmonella* carcass contamination





# Origin of Salmonella carcass contamination

70% from the animal itself

Berends et al 1997:

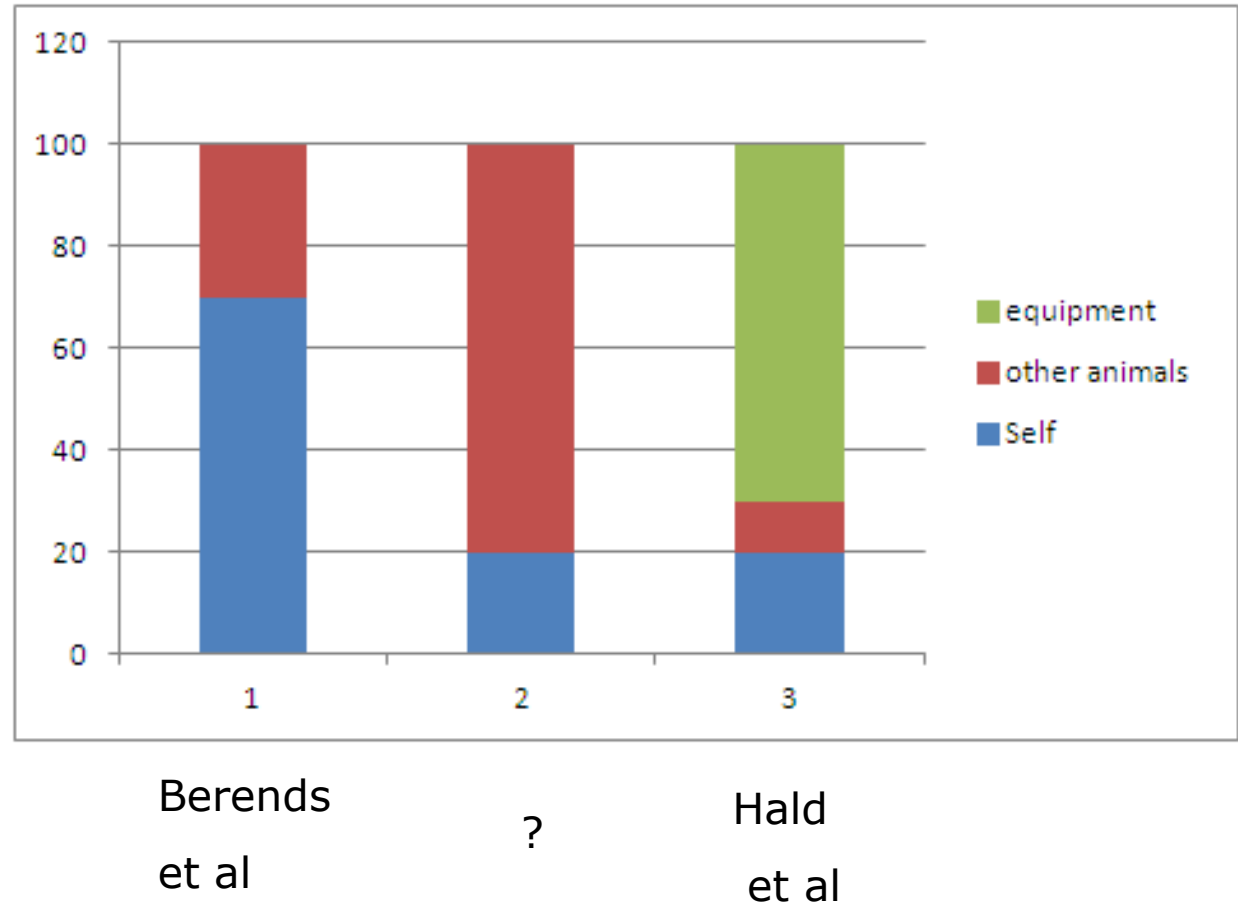
Wu et al 2009.

Main source equipment:

Polisher, pluck removal

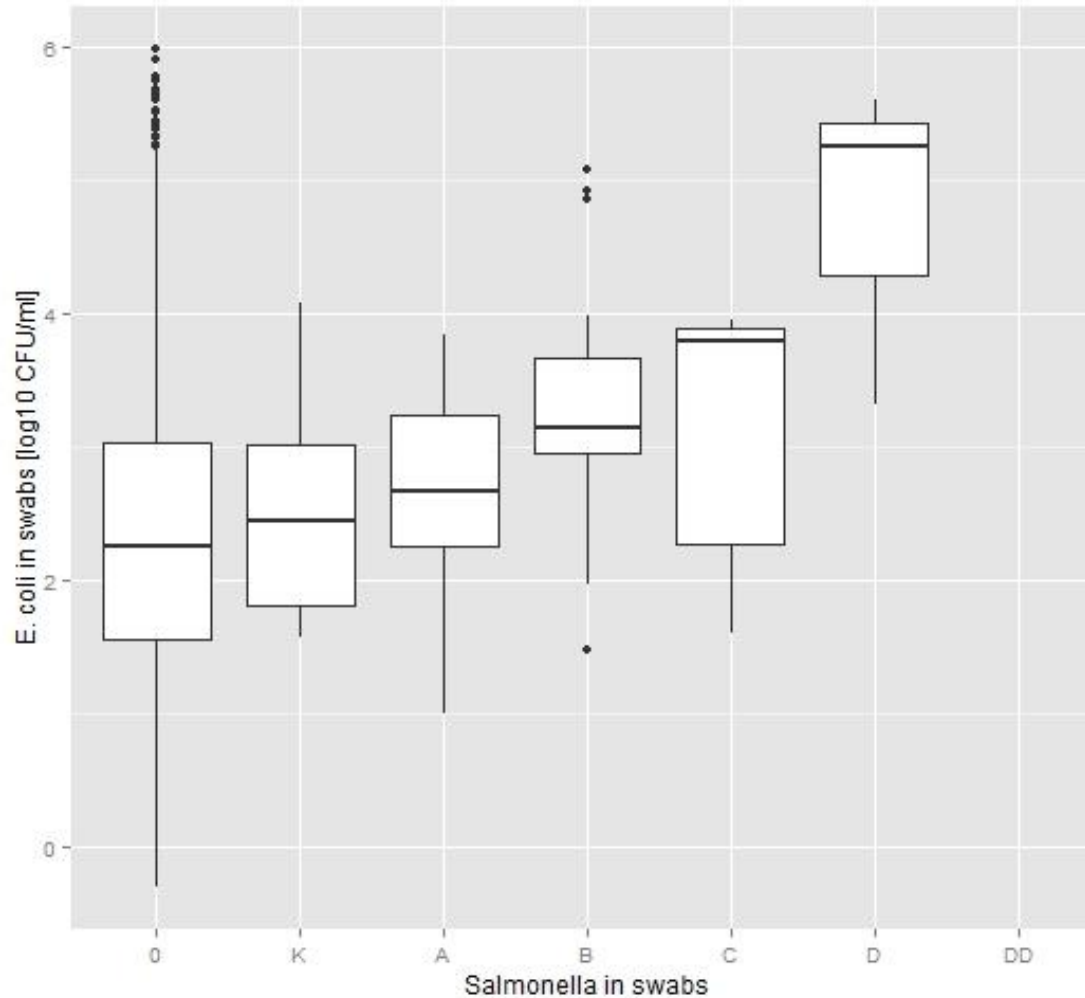
Hald et al. 2003

Smid et al. 2012



## Relationship between *Salmonella* positive carcasses (%) and level of *E. coli* on carcasses.

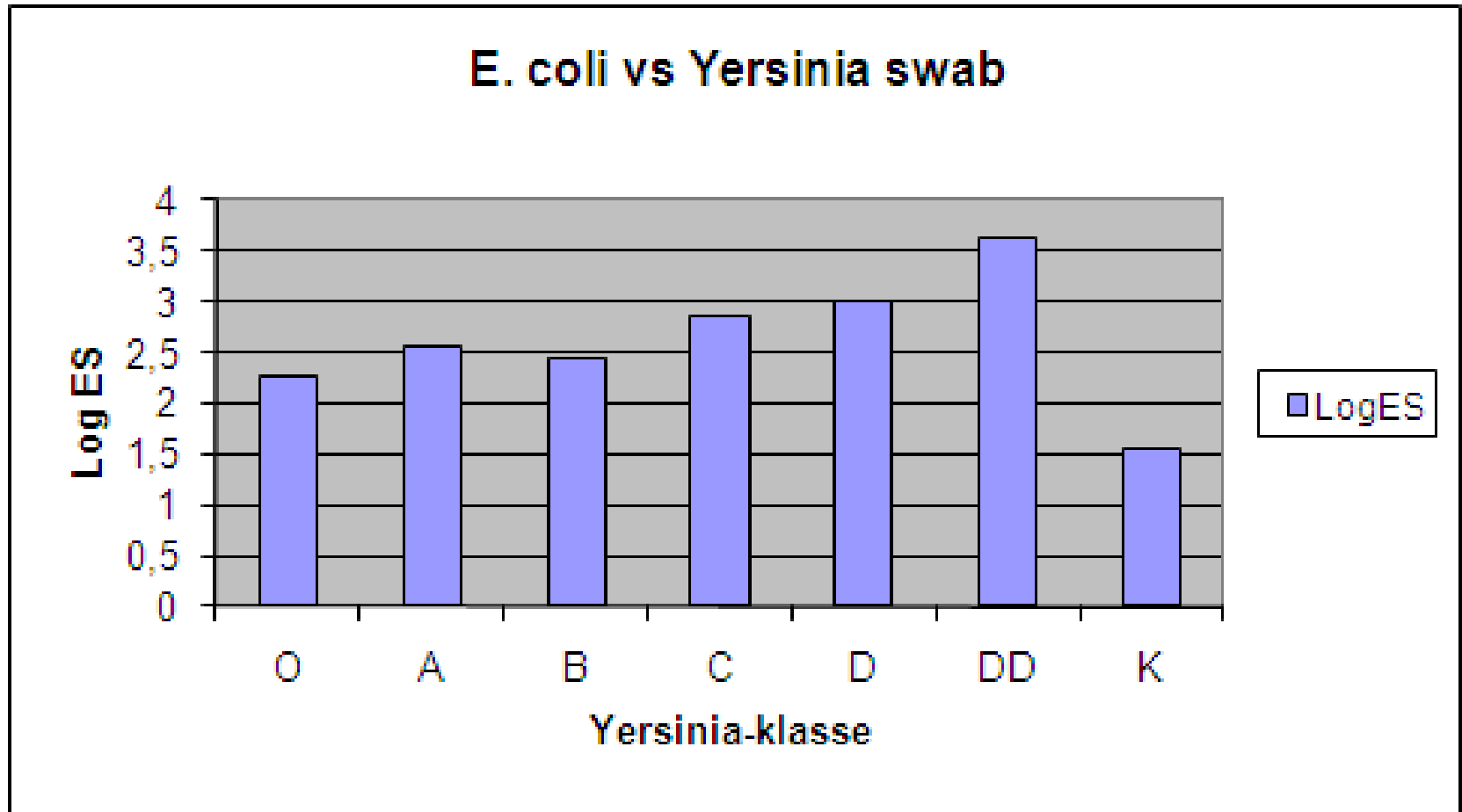
	<b>E. coli in carcass swab [logCFU/ml]</b>					
	0-1	1-2	2-3	3-4	4-5	5-6
<b>Salmonella Prævalens [%]</b>	0.4	1.1	1.9	6.1	2.7	6.8
<b>95 % Confidence Interval</b>	0,01- 2,36	0,41- 2,39	1,01- 3,37	3,88- 9,13	0,57- 7,76	1,43- 18,66



**Figur 1** - Box-plot af *E. coli* niveauet opdelt efter koncentrationen af *Salmonella*.

Bogstaverne repræsenterer følgende koncentrations intervaller: K < 0,10 CFU/ml, A: 0,10 – 0,91 CFU/ml, B: 0,91 – 10,1 CFU/ml, C: 10,1 – 101 CFU/ml, D: 101 – 909 CFU/ml, DD > 909 CFU/ml.

# Relationship between E. coli and Yersinia on pig carcasses



# Correlation between *Salmonella* prevalence and level of *E. coli* in minced meat

	E. coli level CFU/ gram			
	<10	10-49	50-99	100-499
Salmonella præv. (%)	0	1,4	3,4	7,7

Kilde: FVST

# ***Salmonella* risk modelling based on *E. coli* on pig carcasses at slaughter**

## **Simple assumptions:**

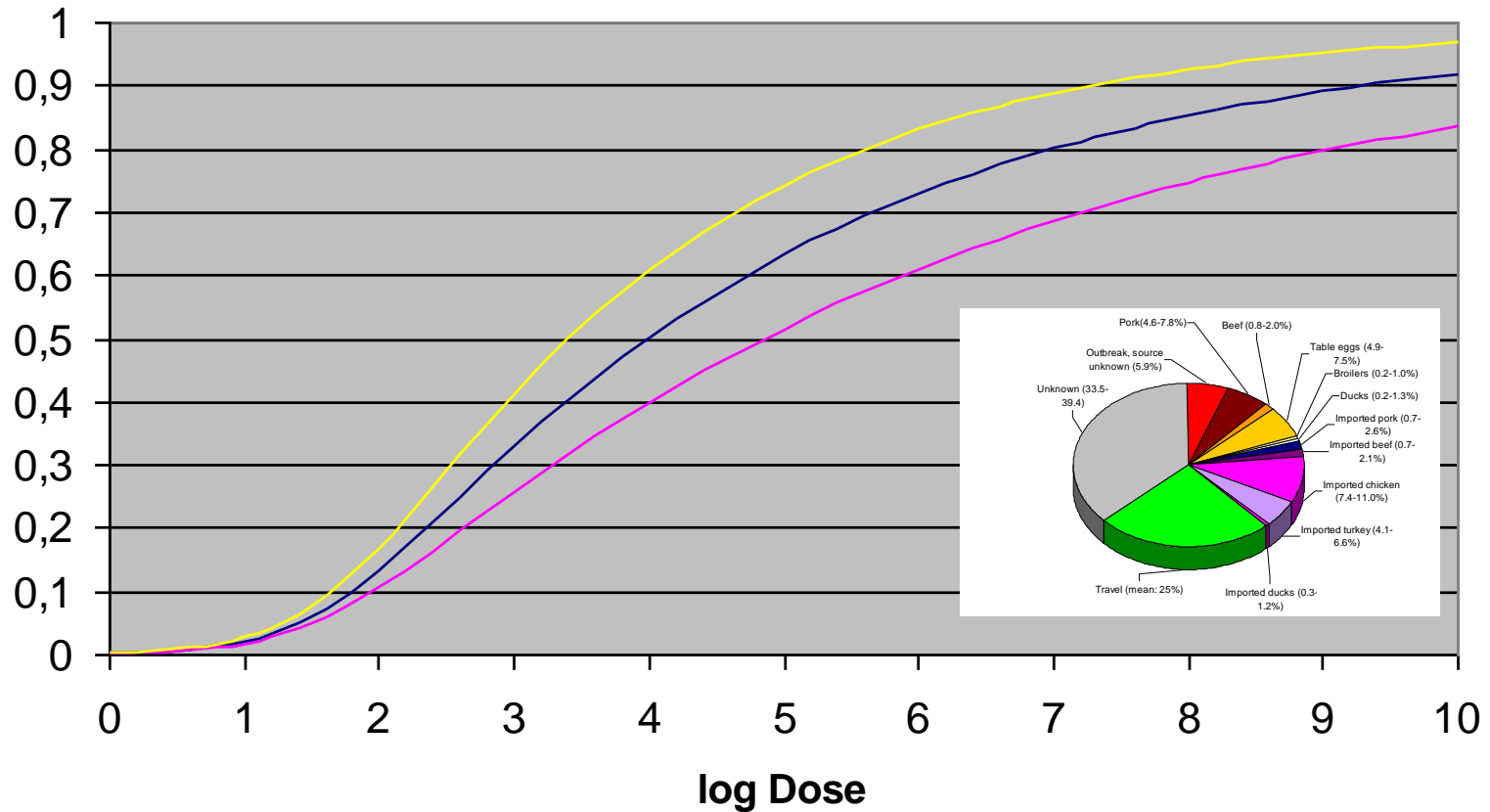
- **meat do not change microbiology from slaughter to consumer.**
- **All meat is consumed raw.**
- **Numbers of Salmonella on carcasses (75 kg)**

**Salmonella per serving (200 g)**

- **Use the correlation between *E. coli* and *Salmonella***
- **Anchor the risk modelling to source attribution in Denmark**

# Beta-Poisson Dose-response

$$P_{inf} = 1 - (1 + \text{Dose}/\beta)^{-\alpha} \quad (\alpha, \beta = 0.132, 51.5, \text{FAO/WHO 2008})$$



—  $P_{ill}$  — 2.5th — 97.5th

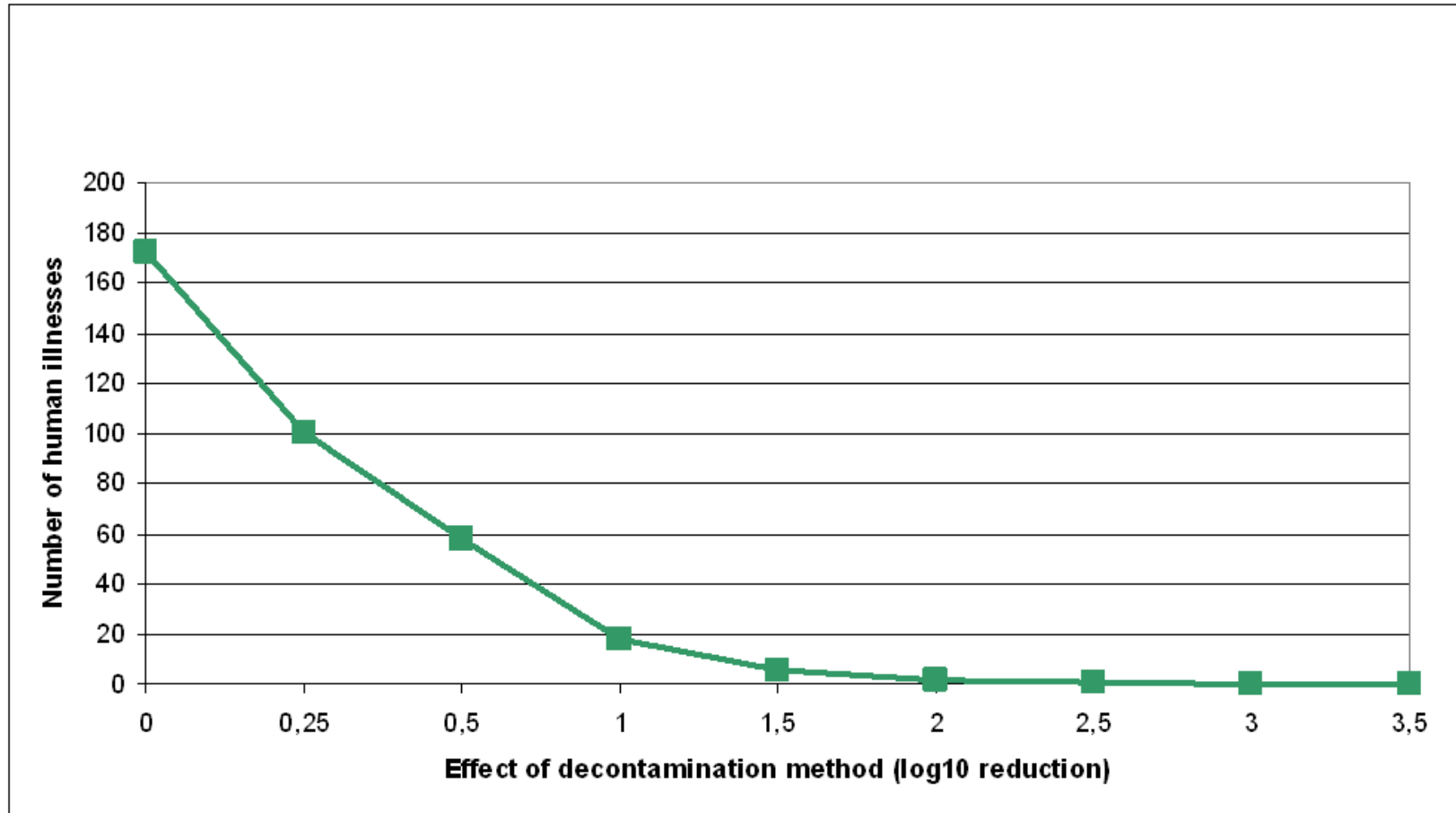
## Number of *Salmonella* cases attributed to level of *E. coli* contamination of pig carcasses.

(Based on the *Salmonella* source account for 2006 , Annual Report on Zoonosis in Denmark.)

	<b>E. coli niveau [log CFU/ml]</b>					
	<b>0 - 1</b>	<b>1 - 2</b>	<b>2 - 3</b>	<b>3 - 4</b>	<b>4 - 5</b>	<b>5 - 6</b>
<b>No cases ass. to E. coli group</b>	<b>0,0</b>	<b>6,3</b>	<b>1,6</b>	<b>40,7</b>	<b>0,6</b>	<b>51,8</b>
<b>Accumul ated no cases</b>	<b>0,0</b>	<b>6,3</b>	<b>7,9</b>	<b>48,6</b>	<b>49,2</b>	<b>101,0</b>



# Impact of reducing the *Salmonella* levels in pork on human infections in DK.



## Conclusions 1

Enteropathogens and spoilage bacteria spreads to carcasses at slaughter

Level of contamination at slaughter (*E. coli*) correlates to level of *Salmonella*

Not necessarily the same association between countries or between eg small and large slaughterhouses

## Conclusions 2

Consumer risk modeling based on *E. coli* contamination can provide hint of:

where to set process hygiene targets/ criteria  
what the impact on human illness may be.

We are under way with principles for risk based approach for statistical process control

An intact cold chain is critical for consumer safety.

The complete story on *Salmonella* from herd via retail to consumer is still hard to tell.

Thank you