Effect of carcass decontamination at pig slaughterhouses on the number of human *Salmonella* cases in Denmark.

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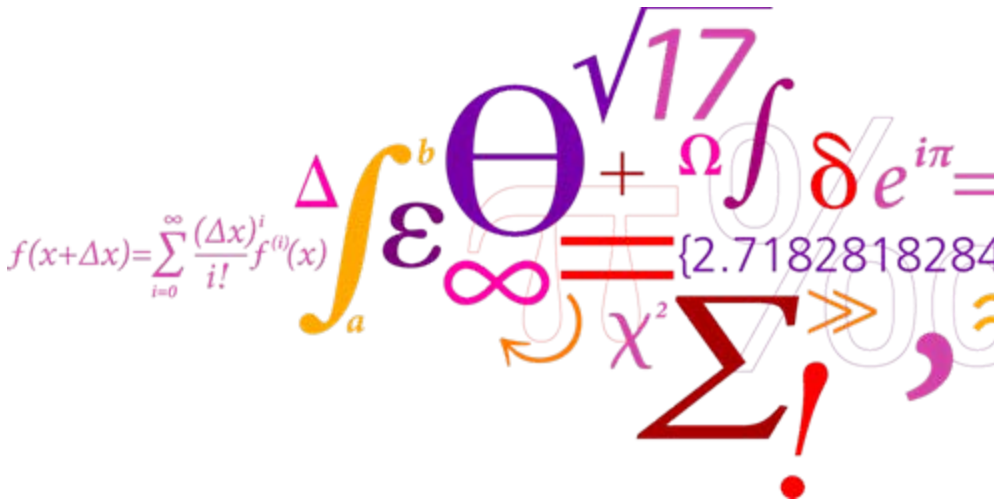


DTU Food
National Food Institute

Danish project:

"DECONT": 2005- 2009

"Efficacy cost benefit and consumer perception of post harvest carcass decontamination of slaughter pigs"

- Data generation
- Effect of steam, hot water and lactic acid decontamination
- Risk modelling
- Cost effect modelling
- Consumer perception
- Willingness to pay

Background for focus on carcass decontamination of pork in Denmark:

E.C. regulation 853, article 3, 2004 opens up for physical decontamination in EU.

Political wish to approach the low Swedish Salmonella levels in pork.

Exhaustion of the current control programs.

Increased industrial interest for end-point decontamination. A simple (and relative cheap) way to improve food safety compared to herd intervention.

Experience with Hot Water Decontamination of 0,5-1 % of production.

Possible significant impact on food safety.

Could be outbreak protective.

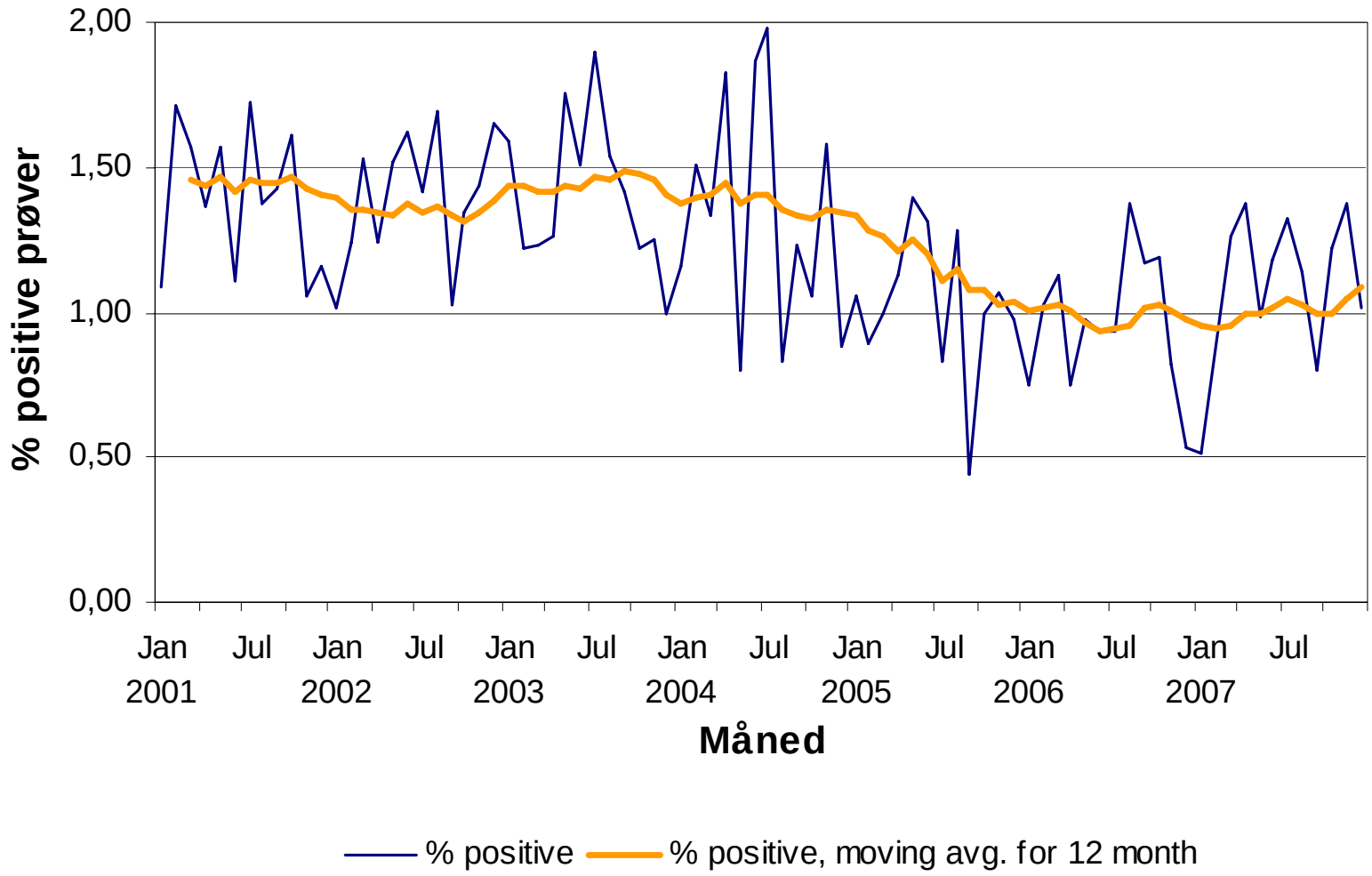
No information on decontamination of pork available from other EU countries.

Concerns about decontamination

- Toxicity of compounds?
- May lead to poor slaughterhygiene?
- Discolouration of meat
- Excessive water consumption (Hot Water Decontamination).
- Consumer acceptance
- May not be installed in small slaughterhouses (Practical/economical reasons)
- Small slaughterhouses – significant suppliers of fresh meat in DK
- Unknown effect on human ilnesses

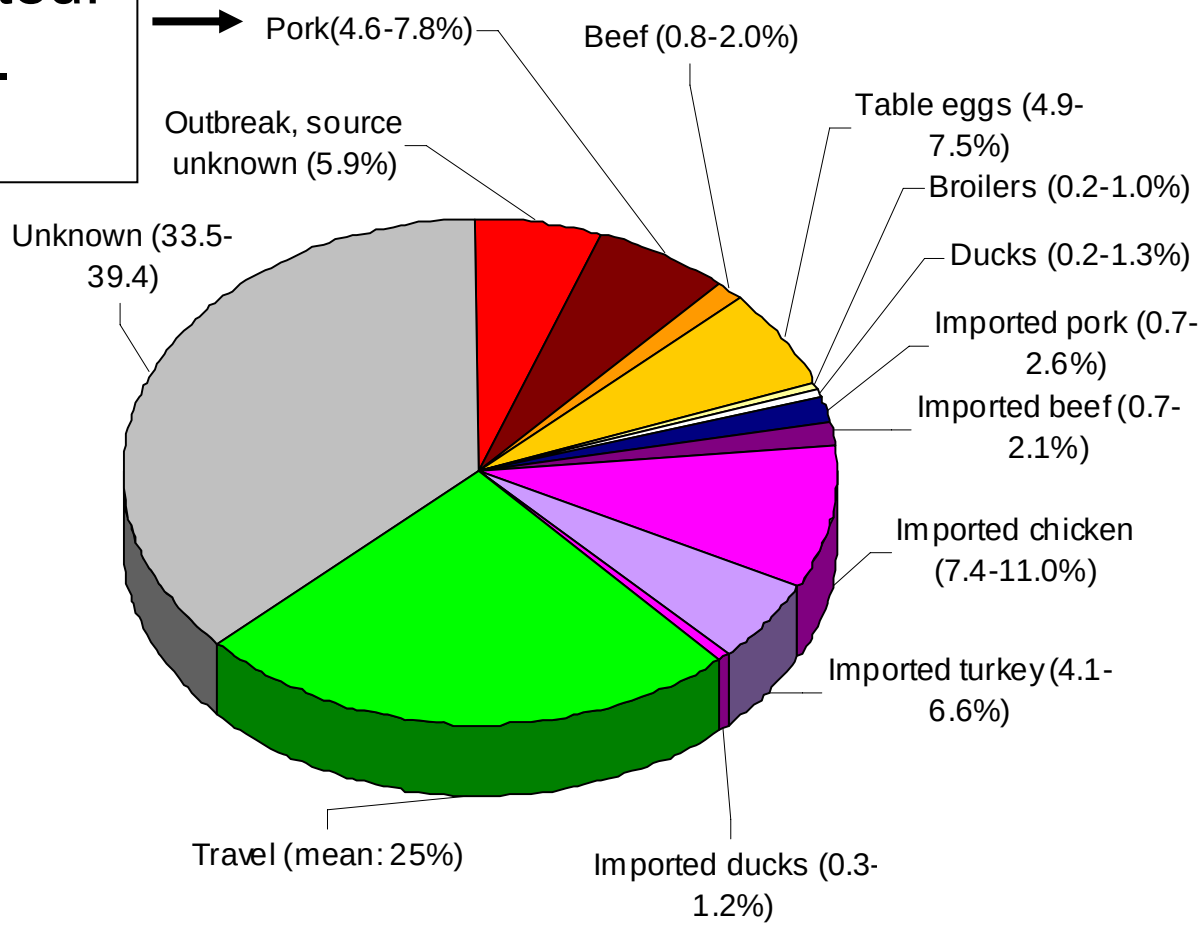
Development of the prevalence of Salmonella on swine carcasses 2001-2007

Bacteriological fresh meat surveillance at slaughterhouses

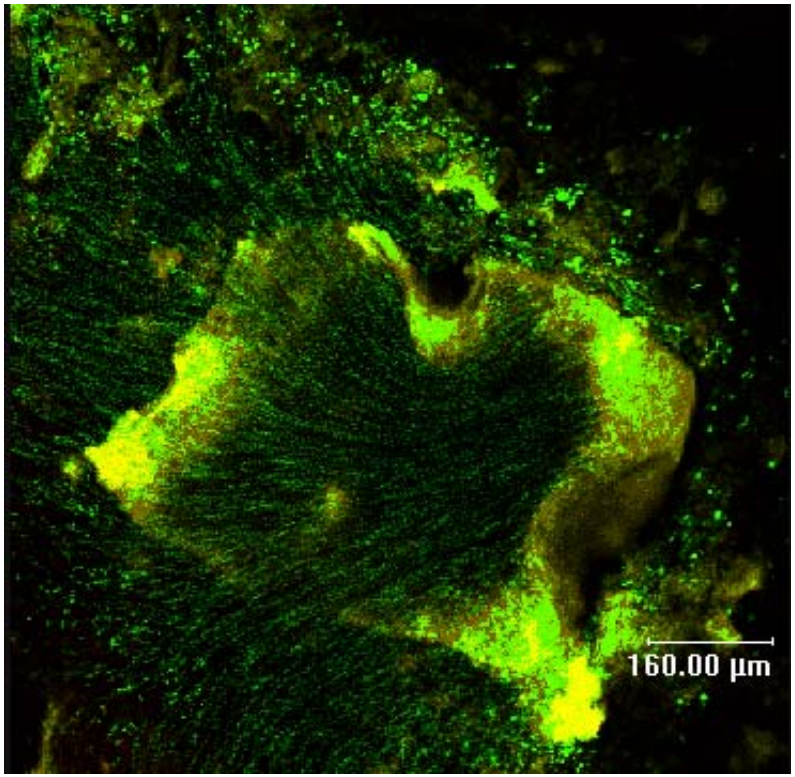


Salmonella source attribution of 1775 registered human cases in Denmark in 2006

Pork associated: 107 (82-138).



Bacteria hide themselves – a challenge to decontamination



Decontamination methods investigated:

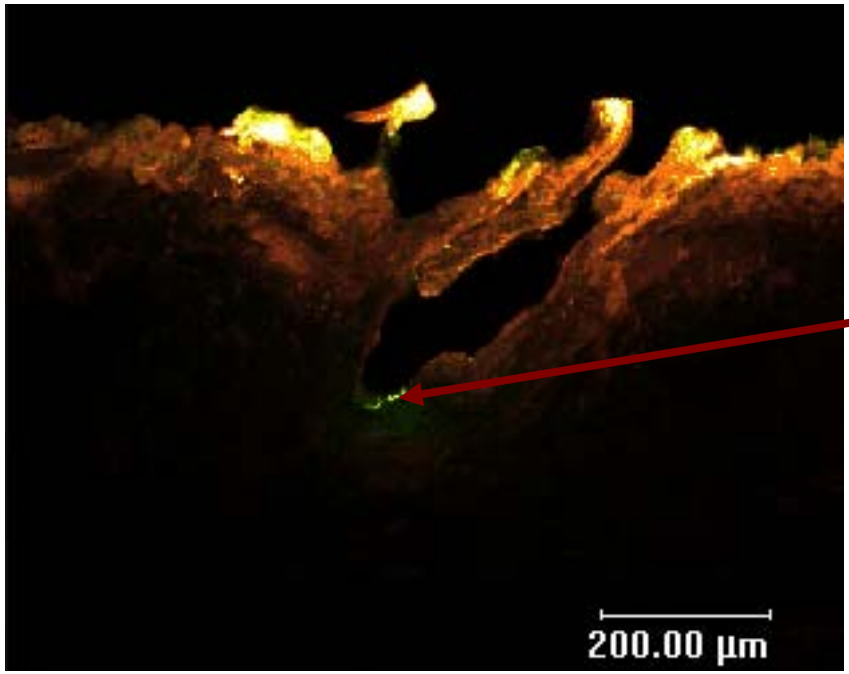
Steam ultra sound

Hot Water Treatment

Lactid acid

Figure 1: CSLM of hair follicle with green fluorescent *Yersinia enterocolitica* moving into the cavity by capillary force. X10

Source: Rikke Krag, KU/ DTU



Gfp-tagged *Yersinia enterocolitica* in hair follicles

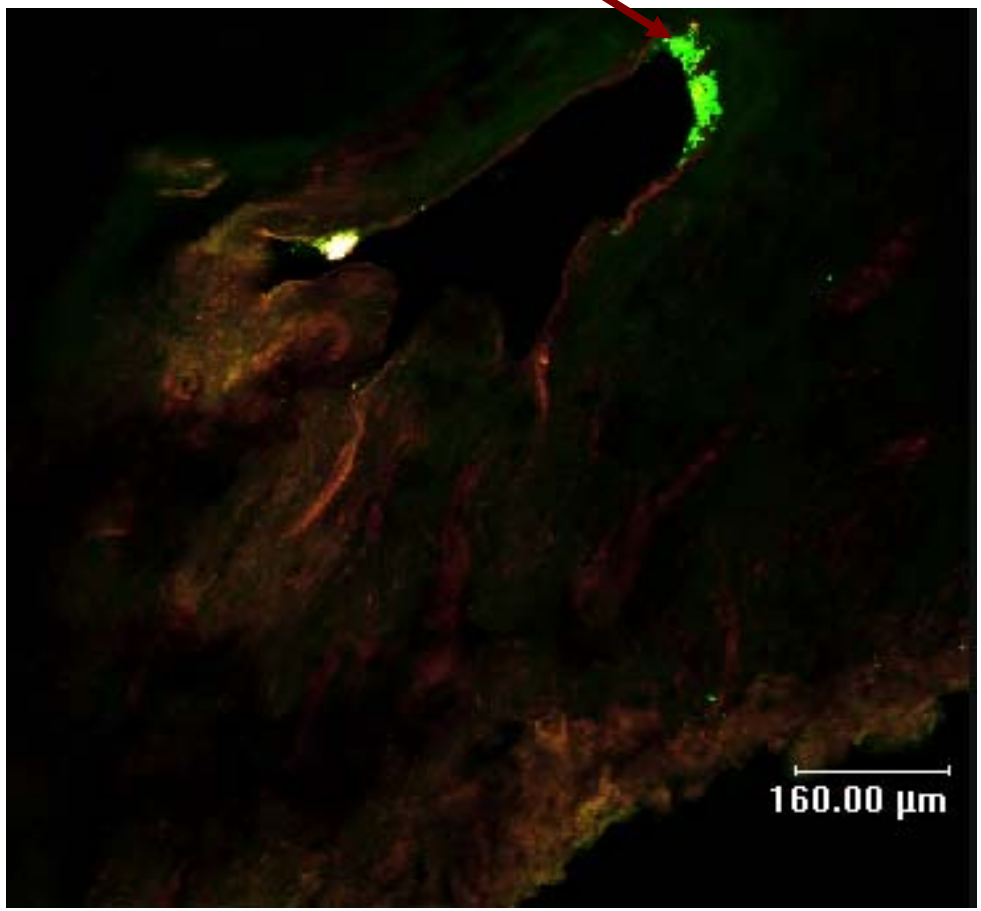
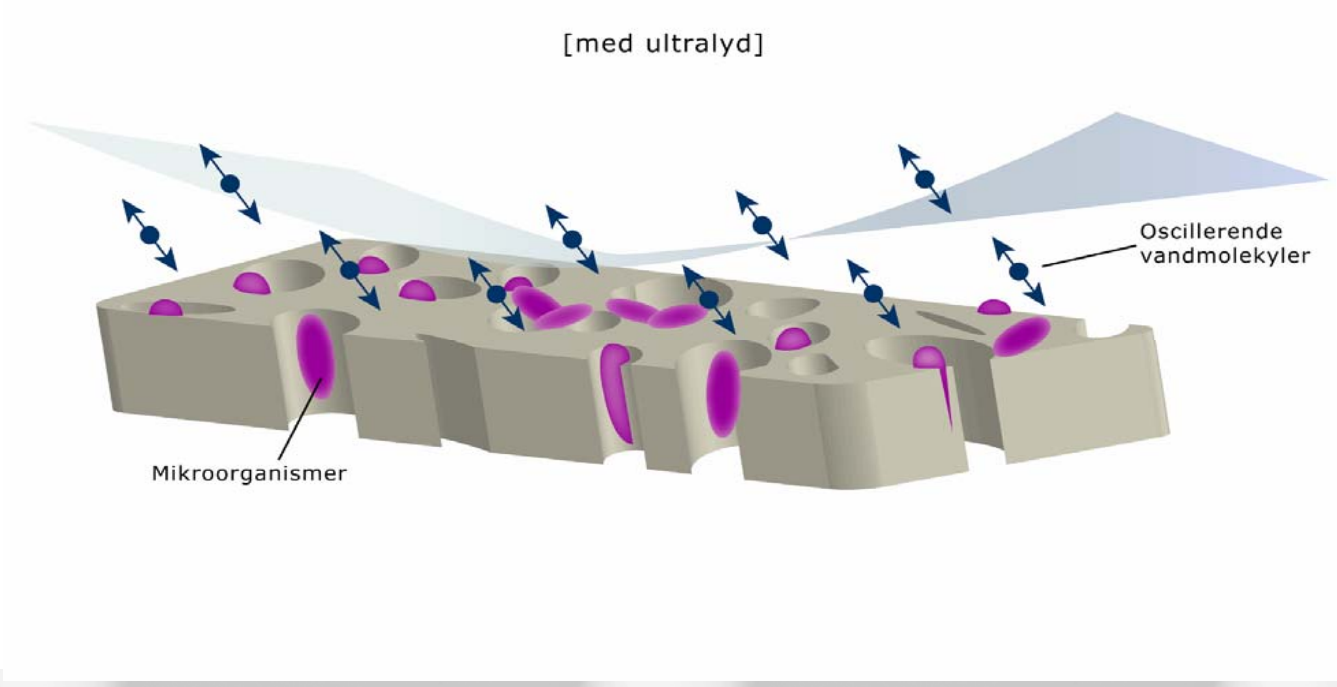
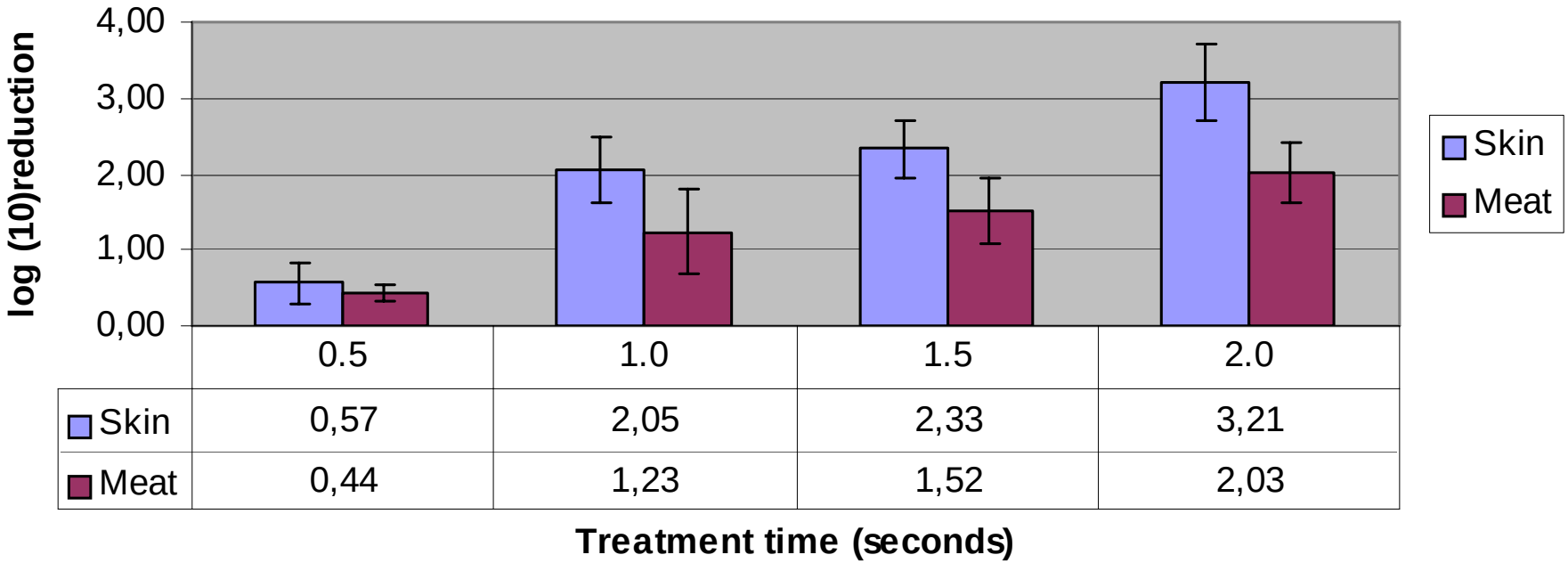


Figure 2
Pork skin inoculated with gfp-tagged *Yersinia enterocolitica* and decontaminated with Sono Steam for 2 sec. After decontamination few bacteria are identified and mainly in deeper tissue structures.

Steam ultrasound - SonoSteam®



Effect of Sonosteam treatment on *Salmonella Typhimurium* seeded (10^7cfu/cm2) on skin and meat side of jaw samples (n=6) ± SD



	0.5	1.0	1.5	2.0
Skin	0,57	2,05	2,33	3,21
Meat	0,44	1,23	1,52	2,03

Hot water Decontamination

80˚C for 15 seconds

Almost all level III herds and all S. Typhimurium DT104 infected herds

Prevalence of Salmonella on carcasses after Hot Water Decontamination

Almost all carcasses from Salmonella level III herds and S. Typhimurium DT104 herds are Hot Water Treated in Denmark = 0,5-1 % of production

Serological level	Salmonella prevalence (%)	
	- HWT	+HWT
I	1,76	0,04
II	3,84	0,31
III	5,07	0,11
	n=30.000	n=9000

Reduction in prevalence : 40-50 fold

Risk model

Modelling carcass contamination before and after decontamination

Modelling no. salmonella bacteria per serving

Dose response modelling and adjusting to the Danish source attribution model

Risk modelling

Exposure model – salmonella on carcasses

Amount of faeces on carcass

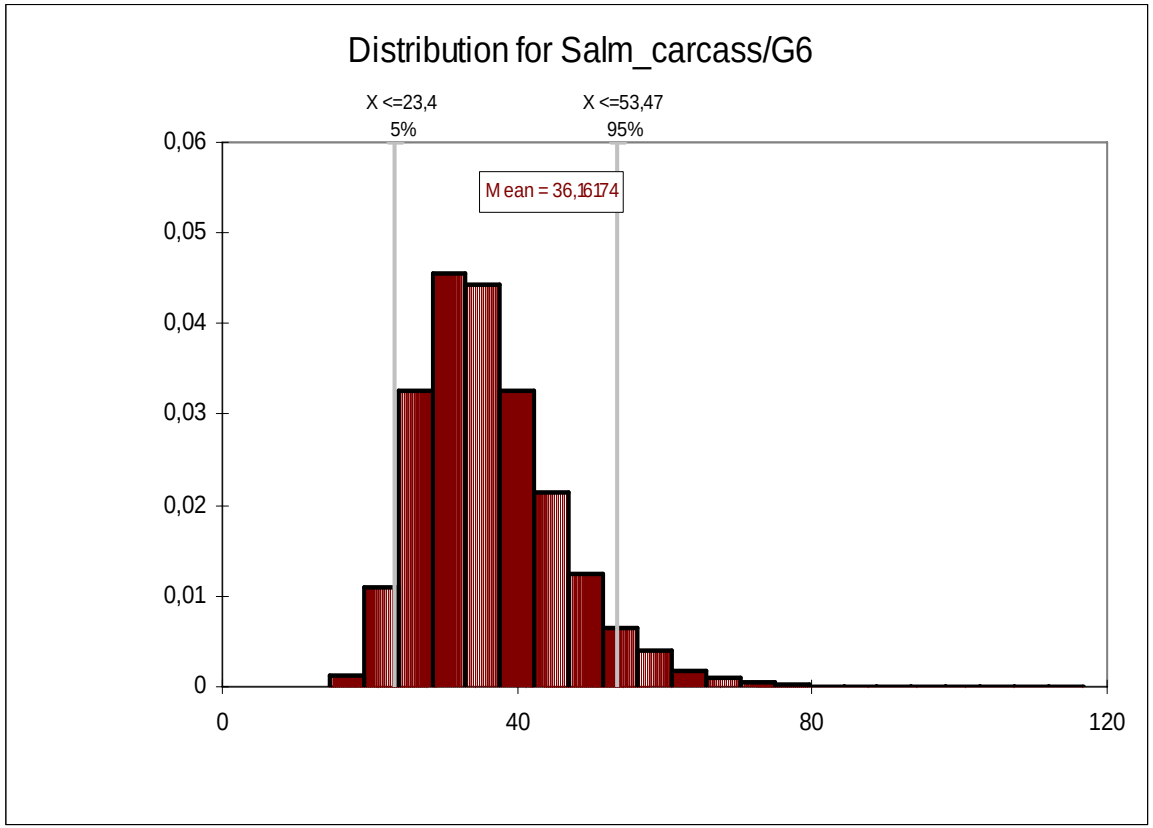
N= 1920

+

Salmonella bacteria in faeces

N=1440

=

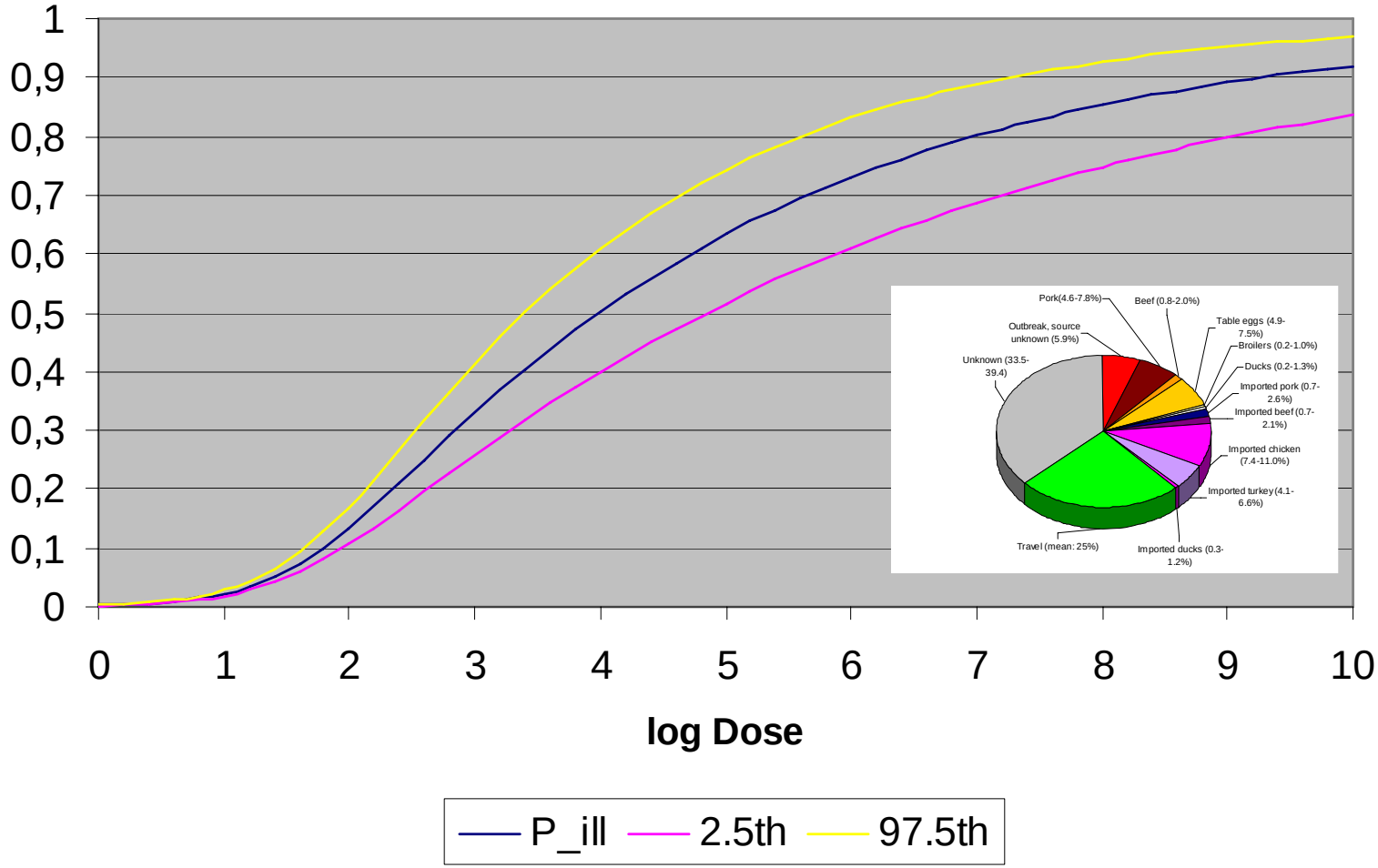


Salmonella per serving

- Salmonella per carcass (75 kg)
- Salmonella per serving (200 g)
- Reduction factor for food preparation
- Salmonella per prepared serving

Beta-Poisson Dose-response

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

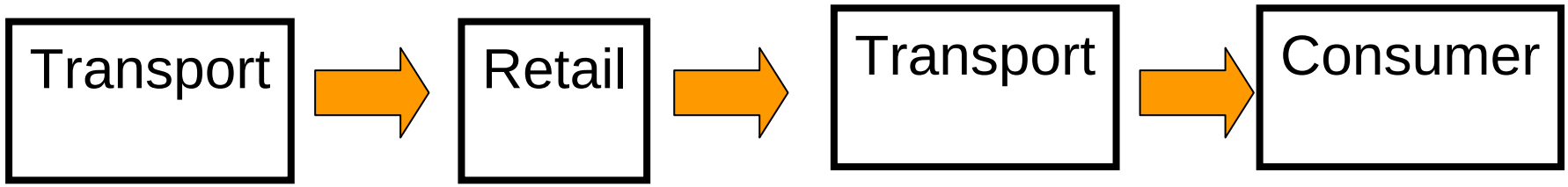


Predicting no. of cases from Relative Risk

Method	Relative Risk	No. of cases/year 2006
No decontamination	1	107
Hot water 80°C 5 secs	0.08	9
Hot water 80°C 15 secs	0.05	5
Hot water 80°C 15 secs 1% lactic acid	0.01	1
Hot water 55°C 2.5% lactic acid	0.12	13

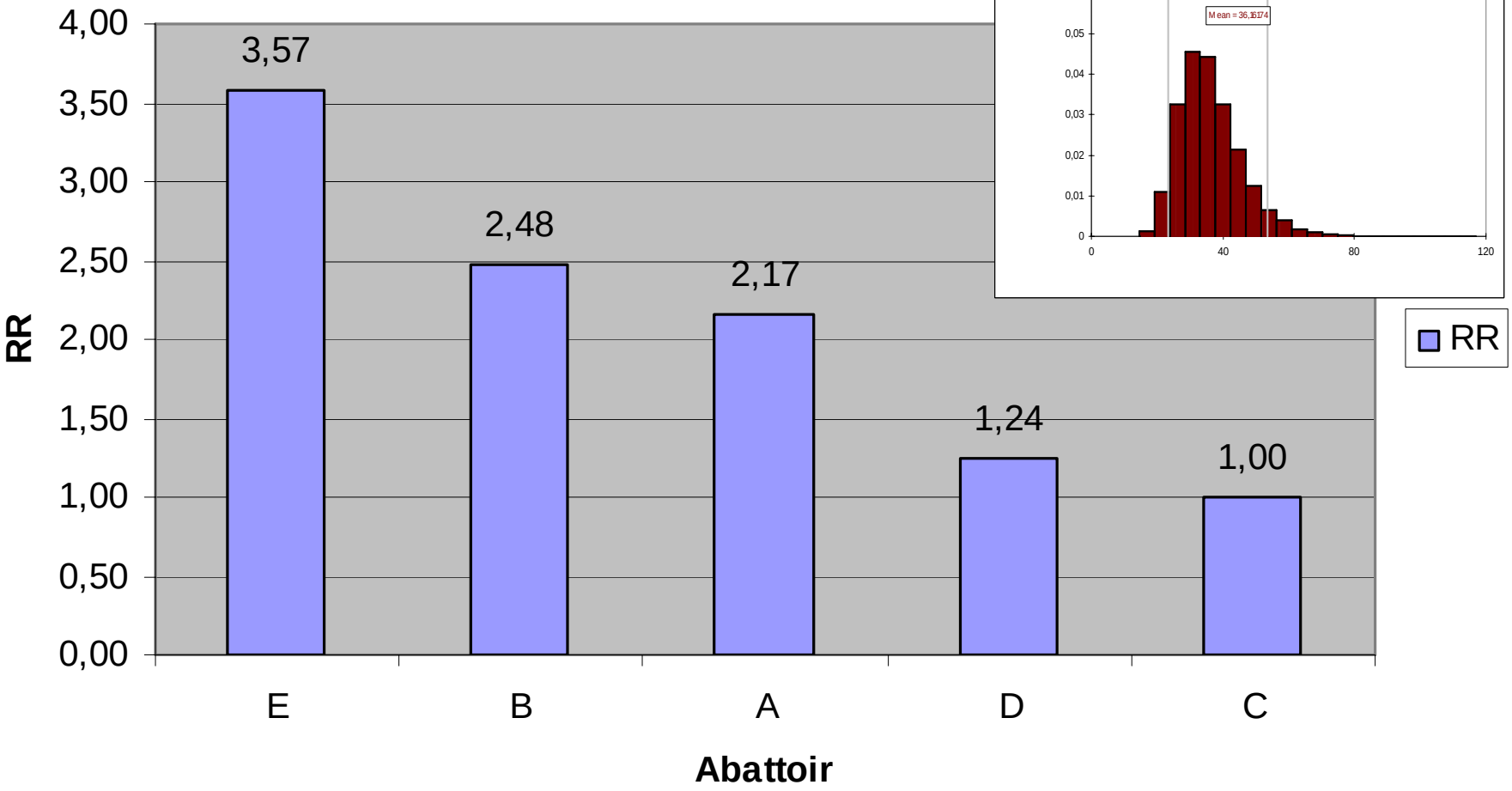
Factors providing uncertainty to the estimate

Methodology and tissue associated effect of decontamination methods

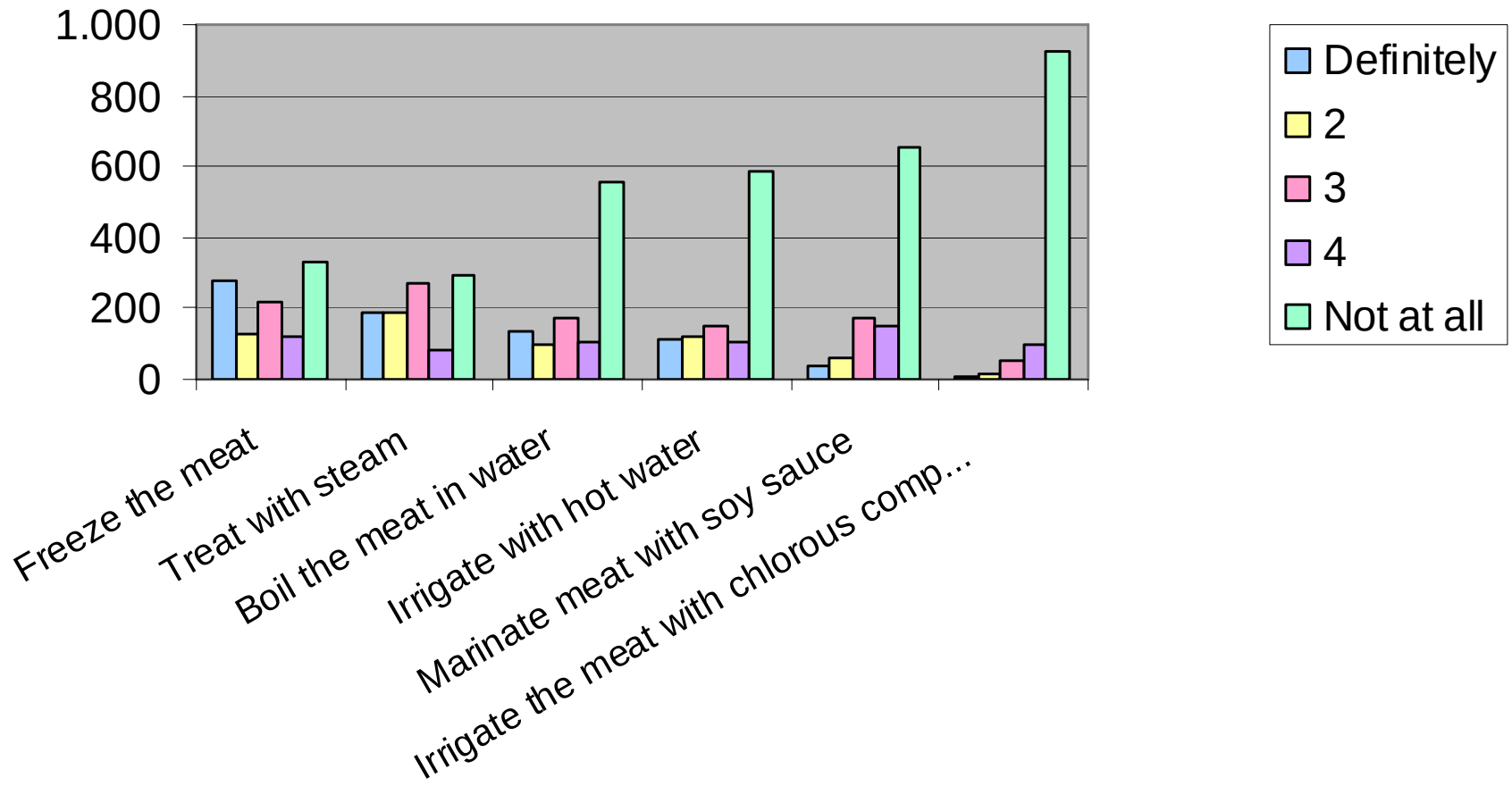


Temperature abuse/growth
Dessication /reduction
Cross contamination
Under cooking
Ready to eat sources

Relative Risk for Human Salmonellosis



Perception of different risk reductions strategies



Conclusion

Decontamination methods available or under development

Potential significant impact on food safety, estimated to 10-100 fold decrease in human illness if all meat is treated.

Slaughter house hygiene have significant effect on human risk

Retail and consumer hygiene level influence the effect of carcass decontamination

Outbreak not included in model

Decontamination may be used for specific purposes (high risk carcasses, meat for fermented products)

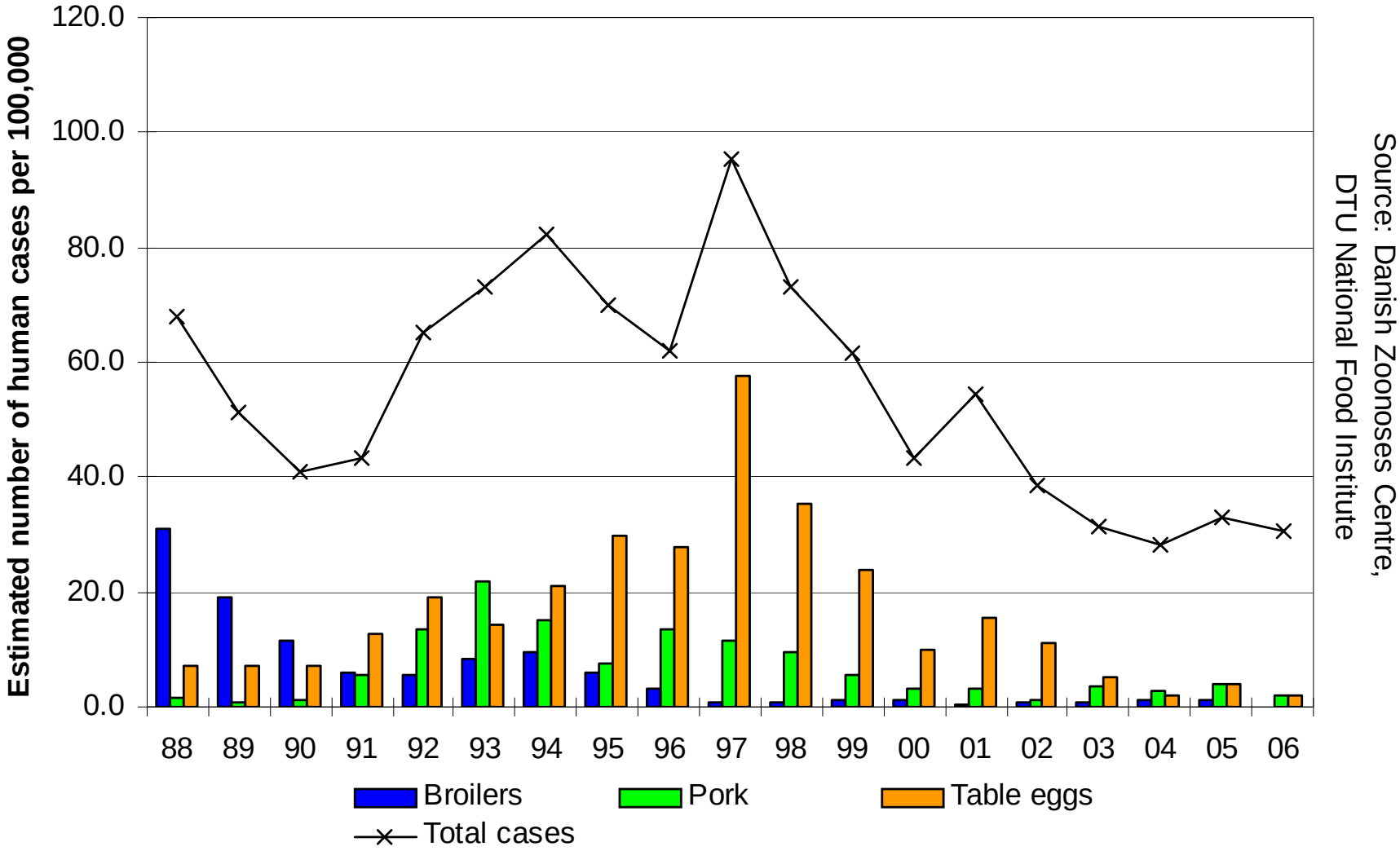
Thank you for your attension

Table 2.Cost data for different decontamination technologies[#]

	Hot water slaughtering	Steam ultrasound	Lactic acid 2.5% 55 °C in 120 seconds
Carcass per year (1000)	740	740	740
Investment (1000 DKK[#])	342	604	12
		1000 € per year	
Capital cost	55	97	2
Energy and water cost	85	27	3
Labour cost	25	0	10
Other variable costs	25	27	5
Total cost	191	150	20
		€ per carcass	
Costs per carcass	0.26	0.20	0.03

[#] Danish Meat Institute (hot water), FORCE Technology (steam ultrasound), SFK Systems, (steam vacuum) and Spraying System (lactic acid spray)

Major foodborne human infections in Denmark 1988-2006



Prevalence of Salmonella positive carcasses for herds in Level I, II, and III with and without Hot water Dewcontamination (HWD)

	Salmonella prevalence estimate (%)*		
	Level I	Level II	Level III
"Routine" slaughter, no HWD	**1,76**	**3,84**	**5,07**
(Number of pools)	**(5130)**	**(560)**	**(6000**)**
Sanitary slaughter with HWD	**0,04**	**0,31**	**0,11**
(Number of pools)	**(919)**	**(288)**	**(621)**

***: adjusted for a sensitivity of 55% due to pooled sampling**
****: individual samples**

Reduction in prevalence : 40-50 fold.

Structure of model: Patogens on carcasses

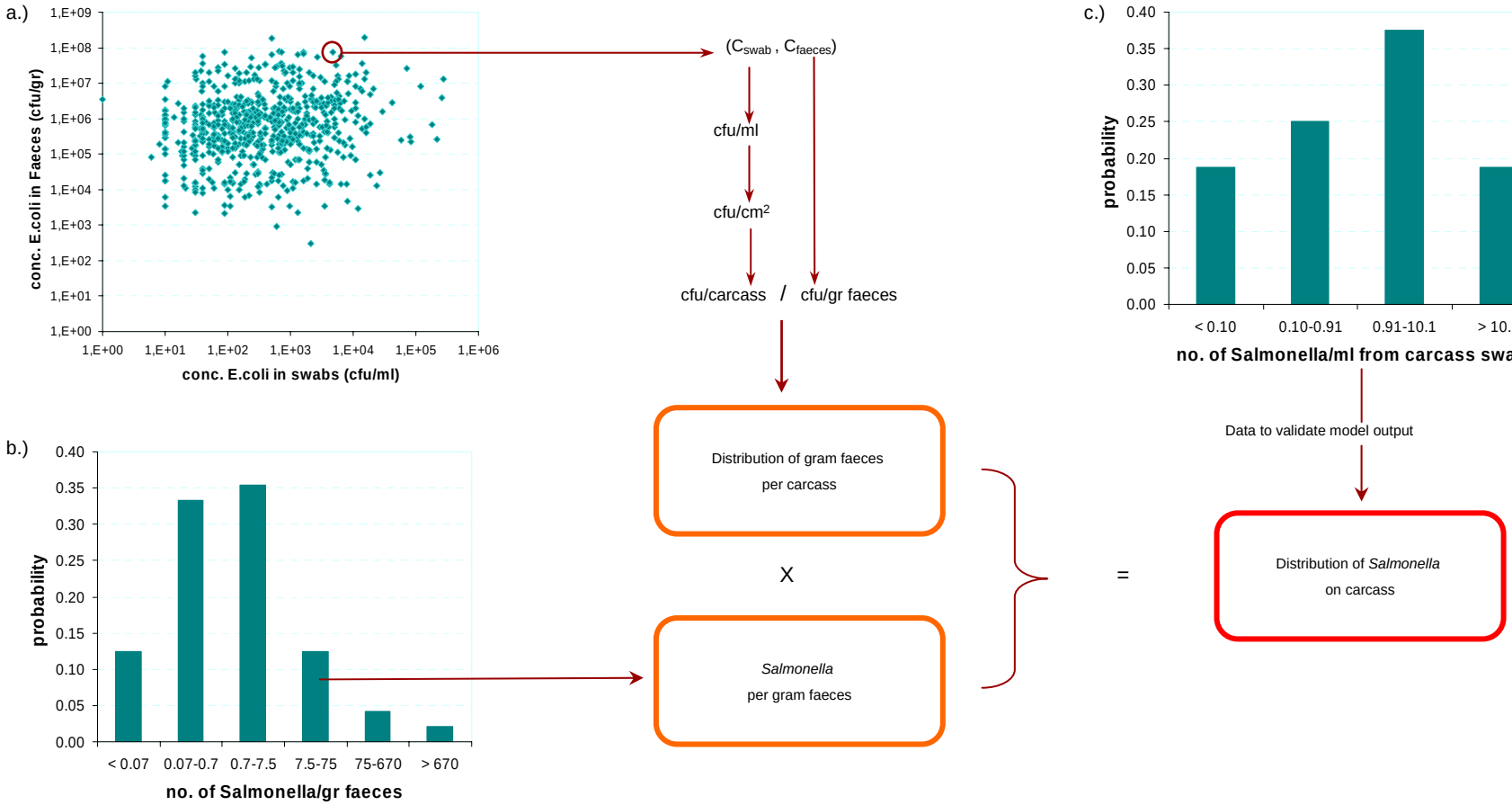
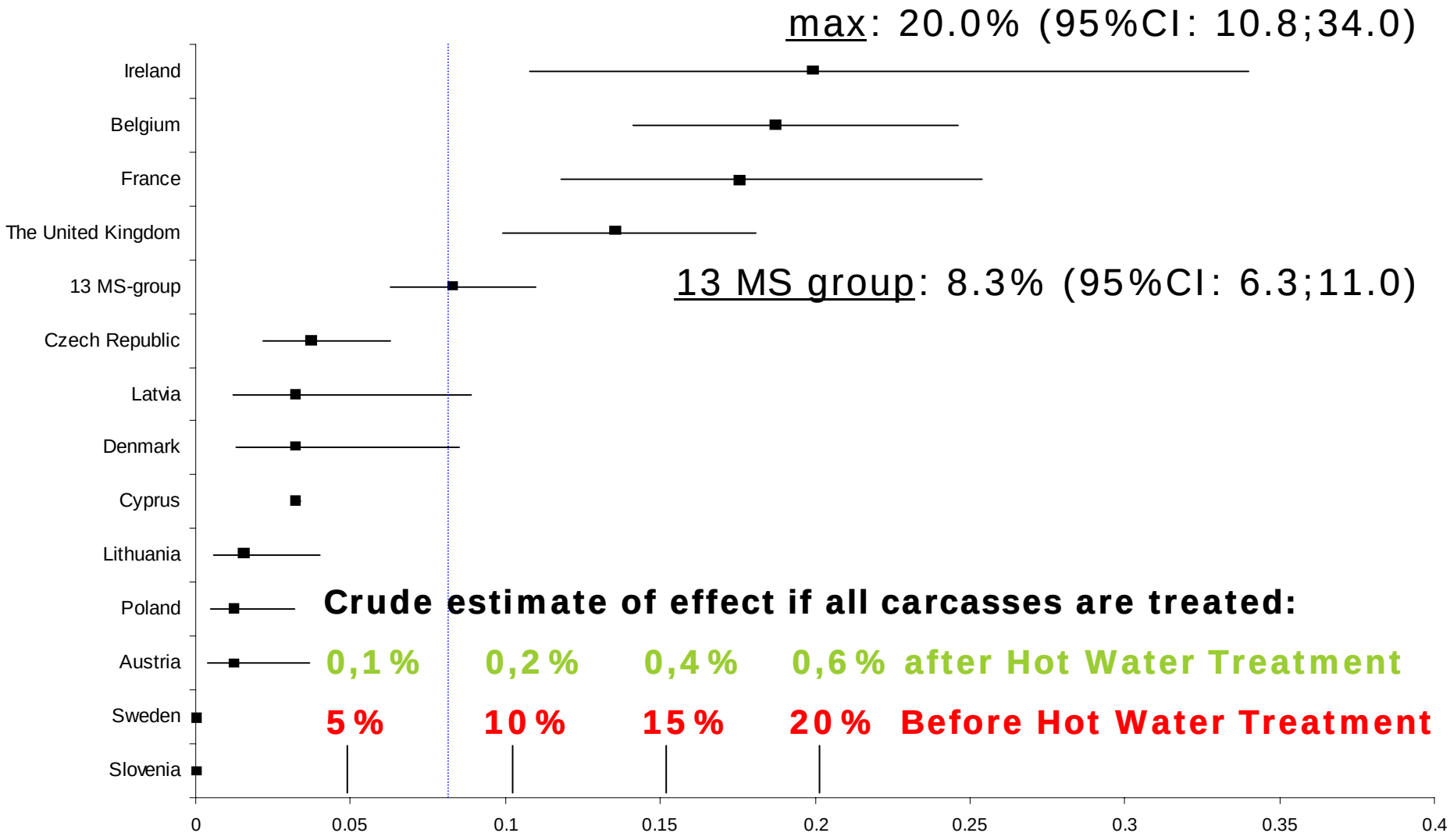


Figure 1. Schematic representation of the simulation model. From a.) paired results of the concentration of *E. coli* in faeces and in carcass swab samples obtained from the same animal, the faecal contamination of the carcass is estimated (i.e cfu/ml in swab ⇒ cfu on 2800 cm^2 swabbed surface ⇒ cfu on total carcass surface). Combining the estimate with b.) the probability distribution of the number of salmonellas per gram faeces from infected swine, results in an estimated number of salmonellas per carcass. The simulation results are validated through carcass measurements of *Salmonella* contamination described in c.) a probability distribution of the number of salmonellas per ml. from carcass swab samples.

Prevalence of Salmonella positive carcass swabs in selected EU countries

(EFSA Salmonella baseline in slaughter swine, carcass swabs, 2008)



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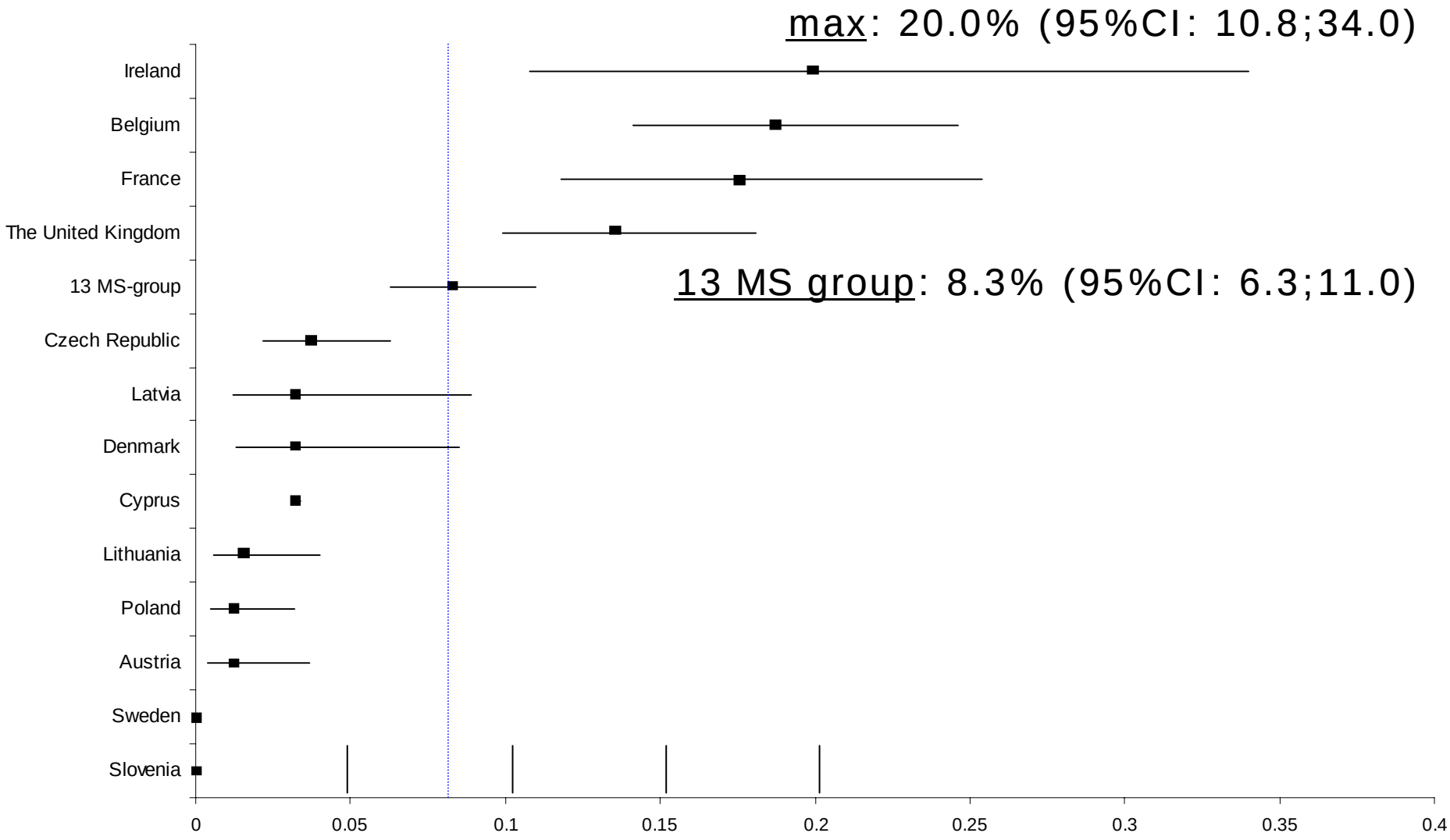

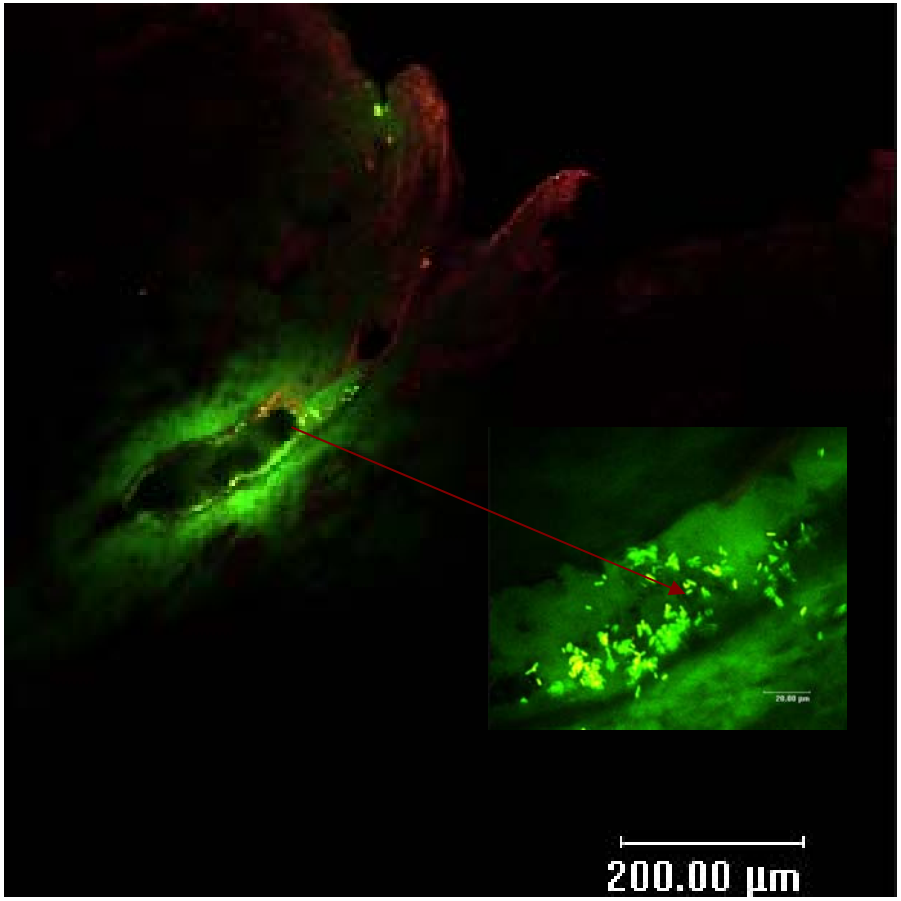

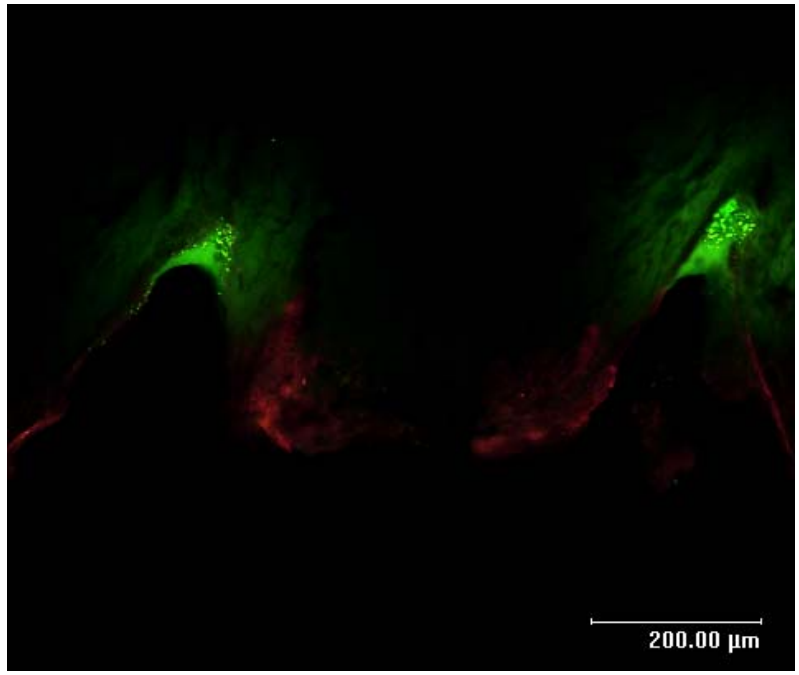

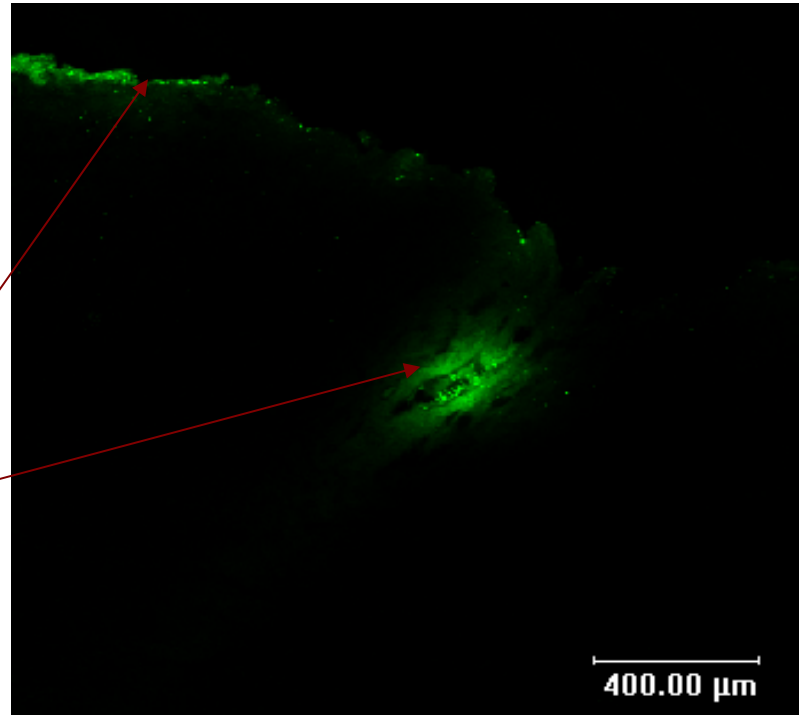

Figure 1a,b and c.
Pork skin inoculated with gfp-tagged *Yersinia enterocolitica* and decontaminated with Sono Steam for 1 sec. After decontamination bacteria are located on skin surfaces and in deeper structures

Gfp-tagged *Yersinia enterocolitica* on the skin surface

Gfp-tagged *Yersinia enterocolitica* in a hair follicle.