

Production systems for laying hens and broilers and risk of human pathogens



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This talk



1. What we think we know



2. Laying hen systems (focus on *Salmonella*)
3. Broiler production systems (focus on *Campylobacter*)
4. Conclusions

What we think we know



Layer and broiler breeds can be infected with human pathogens



Increased environmental exposure to human pathogens (e.g. *Salmonella* and *Campylobacter*)



What we think we know



More difficult to clean and disinfect outdoor holdings?



Level of antibiotic resistance is lower in non-intensive farming – but what about impact of increased therapy?



Laying hens and risk of human pathogens

- AI special problem
- Little evidence of significant transmission of other human pathogens via “spent” hen meat or the layer environment
- Most significant public health risk associated with transmission of *Salmonella* via eggs

Laying hens and risk of human pathogens



- EU ban on conventional caged layer systems
- Enriched cages or non-cage systems only (e.g. free-range, barn, floor-raised/"aviary")
- No separation from faeces
 - increased risk?
- More exposure to natural environments
 - increased risk?
- Potentially more antibiotics needed
 - increased risk?



Salmonella in layers: EU baseline study*



Report on the Analysis of the baseline study on the prevalence of *Salmonella* in holdings of laying hen flocks of *Gallus gallus*, *The EFSA Journal* (2007) 97.

- 2004-2005 data
- 3768 flocks

**Report of the
Task Force on Zoonoses Data Collection
on the Analysis of the baseline study on the
prevalence of *Salmonella* in holdings of laying hen
flocks of *Gallus gallus*¹**

(Question N° EFSA-Q-2006-039)

Adopted by
The Task Force on 20 February 2007

- Caged layers more likely to carry *Salmonella* than non-caged (OR = 5.1)
- Both free-range and floor raised layers had lower *Salmonella* prevalences

*European Food Safety Authority (EFSA) (2007) Report of the Task Force on Zoonoses Data Collection on the Analysis of the baseline study on the prevalence of *Salmonella* in holdings of laying hen flocks of *Gallus gallus*. *EFSA Journal* 97.



EU research project on *Salmonella* in relation to housing systems

- Cross-sectional study (farms in Belgium, Germany, Greece, Italy, Switzerland)
- 292 flocks sampled 1 month prior to depopulation
- Conventional cages and non-cage housing systems
- Farm information collected



Results from EU project on *Salmonella* in relation to the housing system

- **29** / 292 flocks positive for *Salmonella*
 - **17** / 59 conventional, caged flocks
 - **6** / 111 floor raised flocks
 - **5** / 86 free range flocks
 - **1** / 36 organic flocks

Multivariate analysis of factors affecting *Salmonella* in relation housing systems

Continuous variables		Univariable analysis		Multivariable analysis		
		OR	P-value	OR	95% CI for OR	P-value
Age of the infrastructure in years		1.07	<0.01	/	/	/
Number of flocks in the sampled house		1.39	0.04	/	/	/
Number of egg collections per day		0.19	<0.01	/	/	/
Categorical variable	n	OR	P-value	OR	95% CI for OR	P-value
Dry cleaning						
No	52	13.49	<0.01	14.37	4.54–45.51	<0.01
Yes (ref)	240	–	–	–	–	–
Vaccination status against <i>Salmonella</i>						
No	210	2.62	0.13	/	/	/
Yes (ref)	82	–	–	/	/	/
Type of housing						
			<0.01			
Conventional battery (ref)	59	–	–	–	–	<0.01
Indoor production	111	0.09	<0.01	0.05	0.01–0.24	<0.01
Free-range	86	0.16	<0.01	0.18	0.05–0.73	0.02
Organic	36	0.09	0.02	0.17	0.02–1.73	0.13
Season of sampling						
			0.02			
Winter (ref)	49	–	–	–	–	–
Spring	80	0.30	0.04	0.16	0.04–0.73	0.02
Summer	97	0.09	<0.01	0.06	0.01–0.40	<0.01
Autumn	66	0.44	0.15	0.64	0.16–2.60	0.52

*Van Hoorebeke et al., 2010. Preventive Veterinary Medicine



EU research project on *Salmonella* in relation to the housing system

Risk factors for *S. Enteritidis* and/or *S. Typhimurium*:

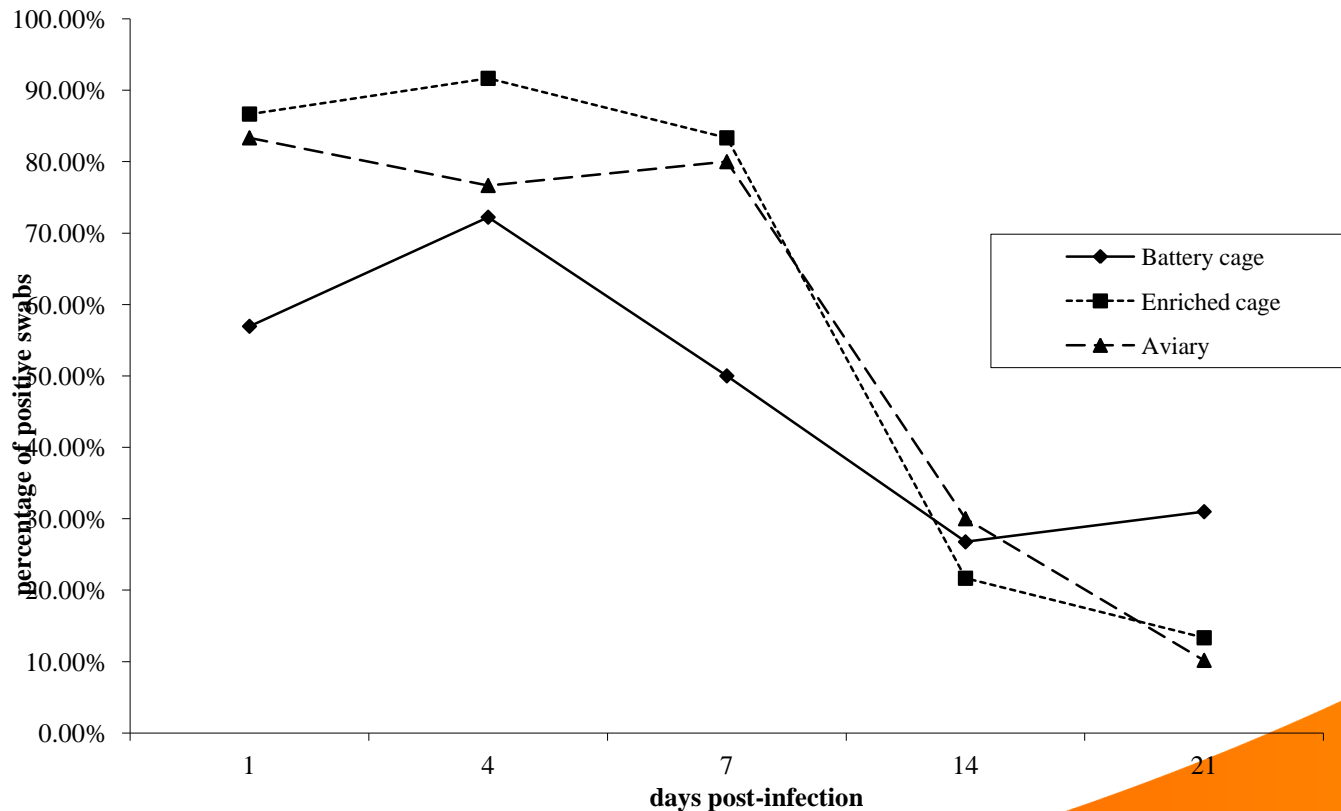
- Housing in conventional cages ($P = 0.01$)
- Absence of dry cleaning ($P < 0.01$)
- Sampling during winter ($P = 0.01$)



EU research project on *Salmonella* in relation to the housing system: Experimental studies

- Layers in enriched (n = 60) and conventional (n = 72) cages and aviary systems investigated
- All animals infected (2.2×10^9 CFU) at 18 weeks of age
- Cloacal swabs taken at day 1, 4, 7, 14 & 21

EU research project on *Salmonella* in relation to the housing system



*De Vylder et al., 2009. Poultry Science

Layer systems and presence of drug resistant bacteria

- Studies suggest layers have lower levels of drug resistant strains compared to pigs or broilers and to a lesser extent cattle
- Lower prevalence of drug resistant strains in organic compared to conventional layers reported from Germany (Schwaiger *et al.* 2008; 2010)



EU research project:

Layer housing system and antimicrobial resistance

- Cross-sectional study (Belgium, Germany, Italy, Switzerland) on 283 farms

Medical treatments on 24 flocks: Colistin (n = 16), Amoxicillin (n = 5), Neomycin (n = 2), Enrofloxacin (n = 1)

- Drug resistance patterns (multiple drug resistance (MDR) = resistance to two or more antimicrobials) for *Escherichia coli* and *Enterococcus faecalis**

*Van Hoorebeke et al., 2011. Epidemiology and infection



EU research project:

Layer housing system and antimicrobial resistance

- 1102 *E. coli* isolates and 792 *E. faecalis* isolates
- Levels of MDR *E. coli* and *E. faecalis* not consistently related to housing type (more MDR *E. coli* in raised-floor systems (68 flocks) than in conventional cage systems (56 flocks) but fewer MDR *E. faecalis* in free-range (122 flocks) compared to conventional cages (56 flocks))
- Other factors including previous usage and premises use (e.g. switch from one system to another) important

Broiler systems and human pathogens

Campylobacter, *Salmonella*, *Listeria monocytogenes* and vero-toxin producing *E. coli* may be found in the GI tract of poultry

Broiler systems and human pathogens

Significant public health problem related to transmission of *Campylobacter* and *Salmonella* from broilers - often via cross-contamination from raw chicken or consumption of under-cooked meat



Broiler systems and *Salmonella*

Salmonella in European broiler flocks*



	% of <i>Salmonella</i>-positive broiler flocks (% S. E / S. T)
	EU survey (05-06)
UK	8.2 (0.2), n = 382
Spain	41 (28), n = 388
Poland	58 (32), n = 357
Italy	28 (23), n = 313
The Netherlands	7.5 (1.0), n = 362
France	6.2 (0.5), n = 381
Denmark	1.6 (0.3), n = 295

http://www.efsa.europa.eu/en/science/monitoring_zoonoses/reports/zoon_report_fibroilers.html

http://www.efsa.europa.eu/cs/BlobServer/DocumentSet/Zoon_report_2006_en_0.pdf?ssbinary=true

EFSA The Community Summary Report on Trends and Sources of Zoonoses and Zoonotic Agents in the European Union in 2007

Salmonella on chicken carcasses in 2008*



	% of Salmonella-positive carcasses (% S.E/S.T)
UK	3.6 (“0”)
Spain	14 (6.8)
Poland	25 (9.6)
Italy	17 (0.3)
The Netherlands	10 (0.2)
France	7.4 (0.2)
Denmark	“0 (0)”

*European Food Safety Authority (EFSA). 2010. Analysis of the baseline survey on the prevalence of Campylobacter in broiler batches and of Campylobacter and Salmonella on broiler carcasses in the EU, 2008, Part A: Campylobacter and Salmonella prevalence estimates. EFSA J. 8:1503.

Evidence from on-farm studies

- Spain: *Salmonella* detected in only one of 60 free-range flocks studied (Esteban et al. 2006) (higher prevalence reported in EU survey data!)
- Belgium, 04 data: No significant difference in *Salmonella* prevalence in organic (9 flocks) and conventional broilers (11 flocks) (Van Overbeke et al. 2006)
- US: more likely to find *Salmonella* in conventional (3 farms) compared to organic (4) farms (Alali et al. 2010); older study found the opposite (Bailey and Cosby et al. 2005)
- Germany: more likely to find *Salmonella* in conventional compared to organic broilers (Wolf-Reuter et al. 2002)
- Italy and the Netherlands: No significant difference between organic and conventional broilers (Pieskus et al. 2008)

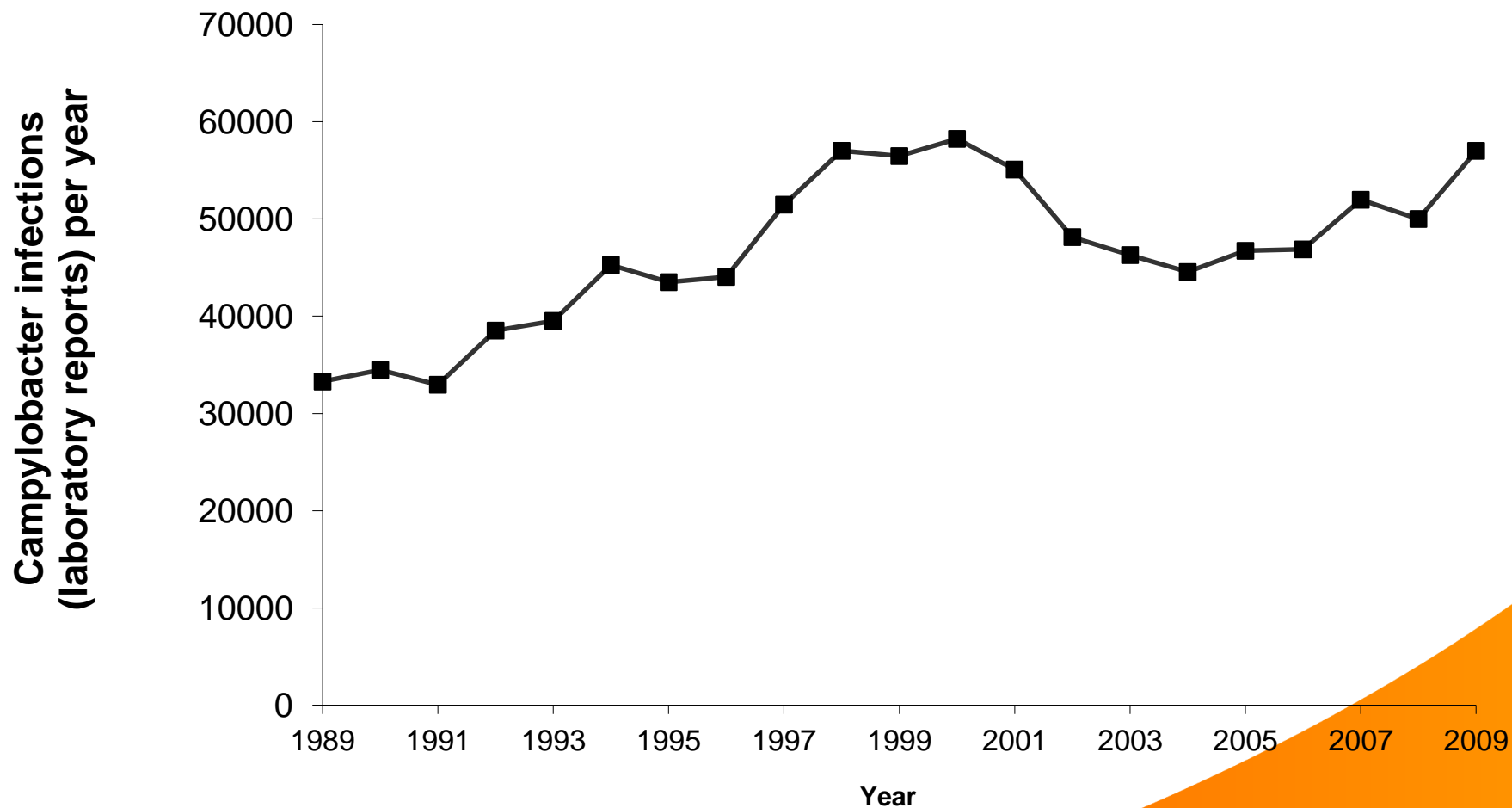
Evidence from retail studies

- UK retail studies (FSA & CLASSP studies; data from 2004-2008) demonstrate that *Salmonella* can be found in standard, organic and free-range chicken
- These studies were not designed to compare *Salmonella* prevalences in meat of standard housed and free-range or organic origin (e.g. only low number of organic and free-range meat tested: 2/29 and 6/161 for organic and free-range, respectively compared to 199/3084 samples from standard housed production)
- older US data found no significant difference in *Salmonella* prevalence in organic compared standard chicken meat



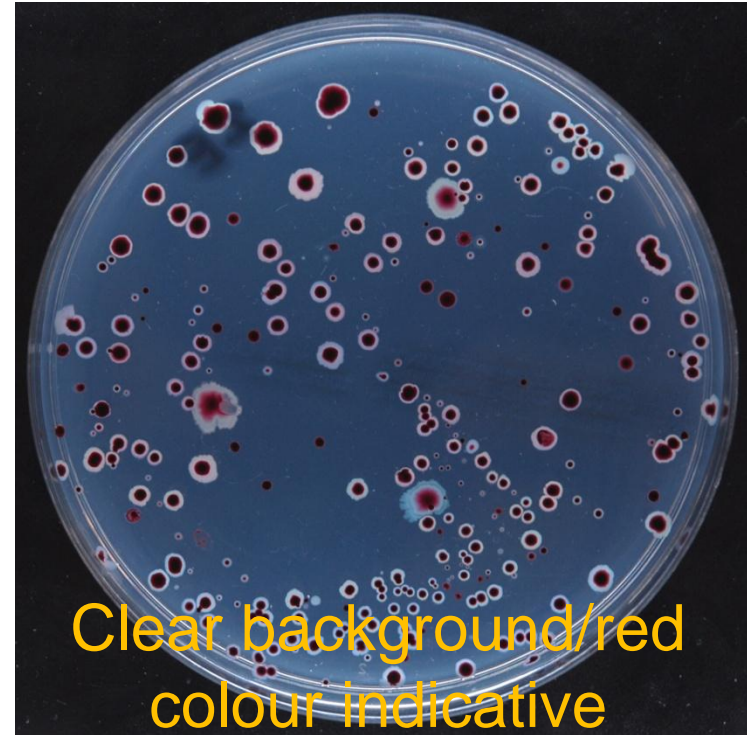
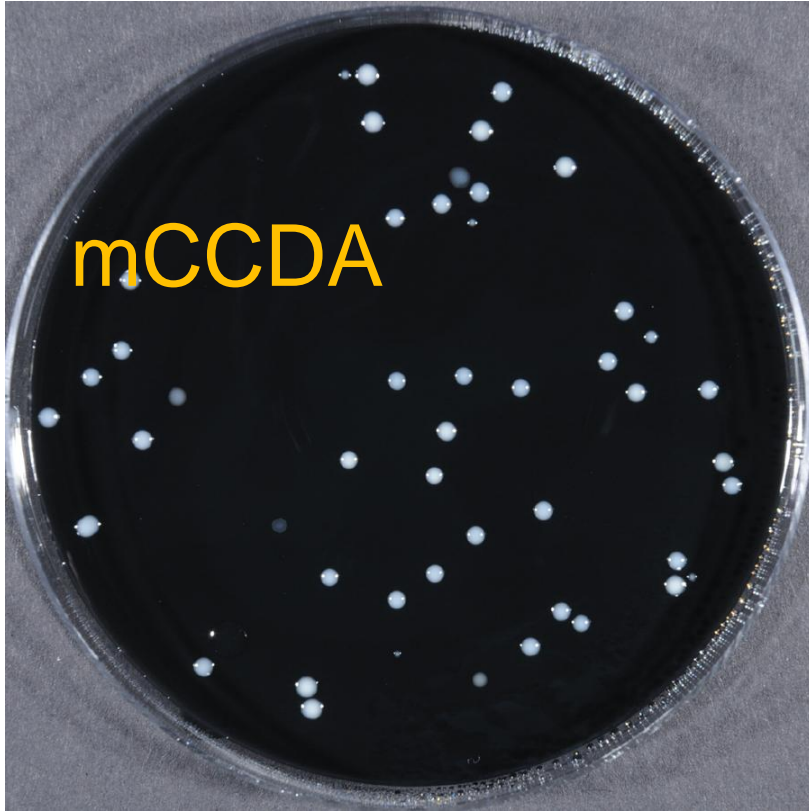
Broiler systems and *Campylobacter*

Reported *Campylobacter* infections in England and Wales



C. jejuni and *C. coli* most common species causing human infections

Campylobacter spp. on agars



Suspect *Campylobacter* colonies:

On mCCDA: 1-2 mm in diameter, greyish and a little translucent, flat and moist colonies, metallic sheen common (but big opaque and very white colonies are not usually *Campylobacter*.)

Identification methods can include:

Checking oxidase

Checking growth in air

If no growth in air and oxidase POS Gram stain or other (wet mount/ phase contrast/motility check)

Antibody agglutination (latex) test OR PCR to confirm *Campylobacter* spp.

Campylobacter prevalence in broilers (EU 2008 baseline survey)



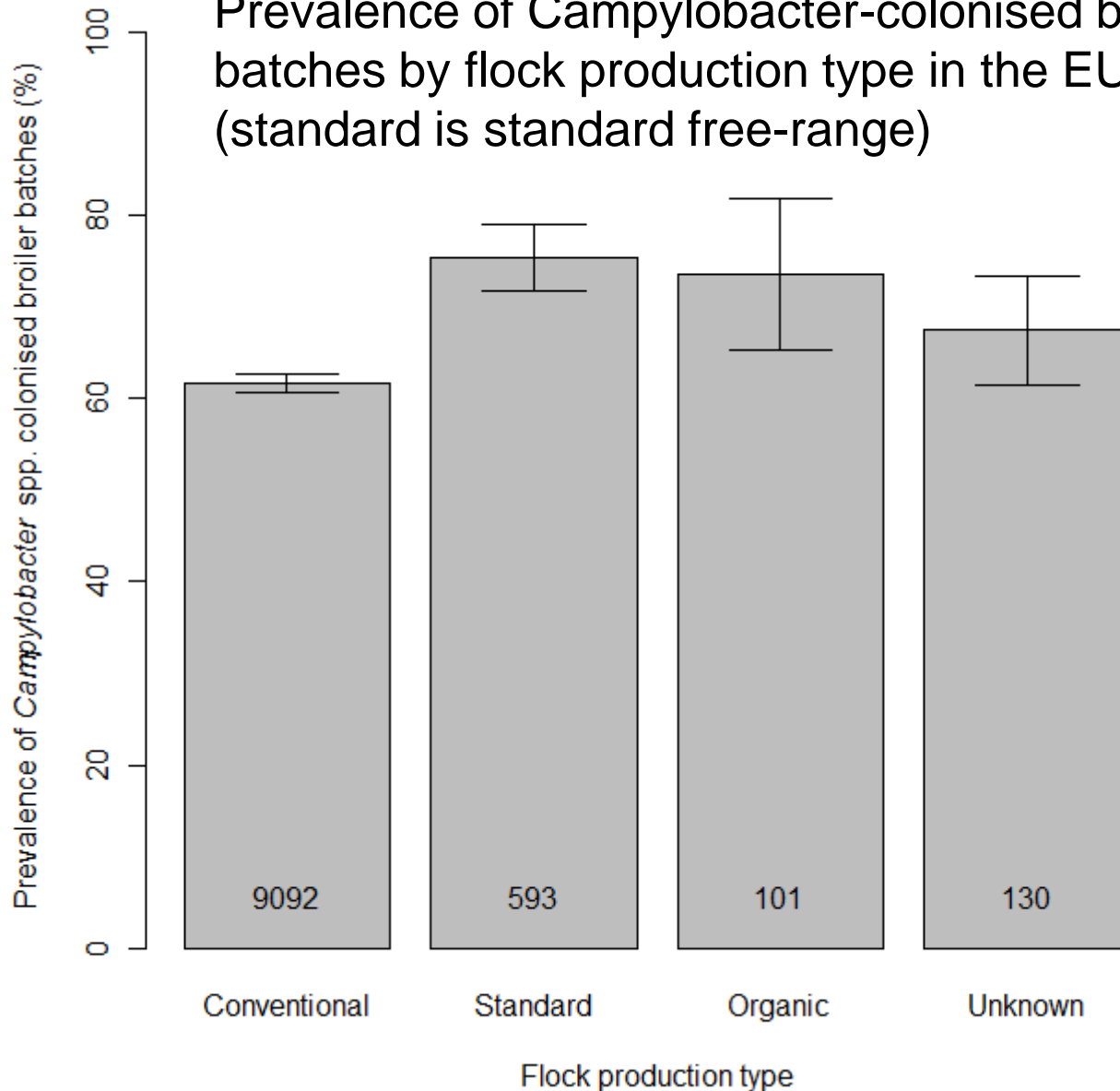
Country	%
Poland	79
France	76
Italy	63
Germany	49
Netherlands	24
Denmark	19
Sweden	13
Norway	3

EU 2008 baseline survey*

- ~ 75 % of UK broiler batches positive (n = 401)
- ~ 86 % of UK chicken carcass batches sampled just after chilling

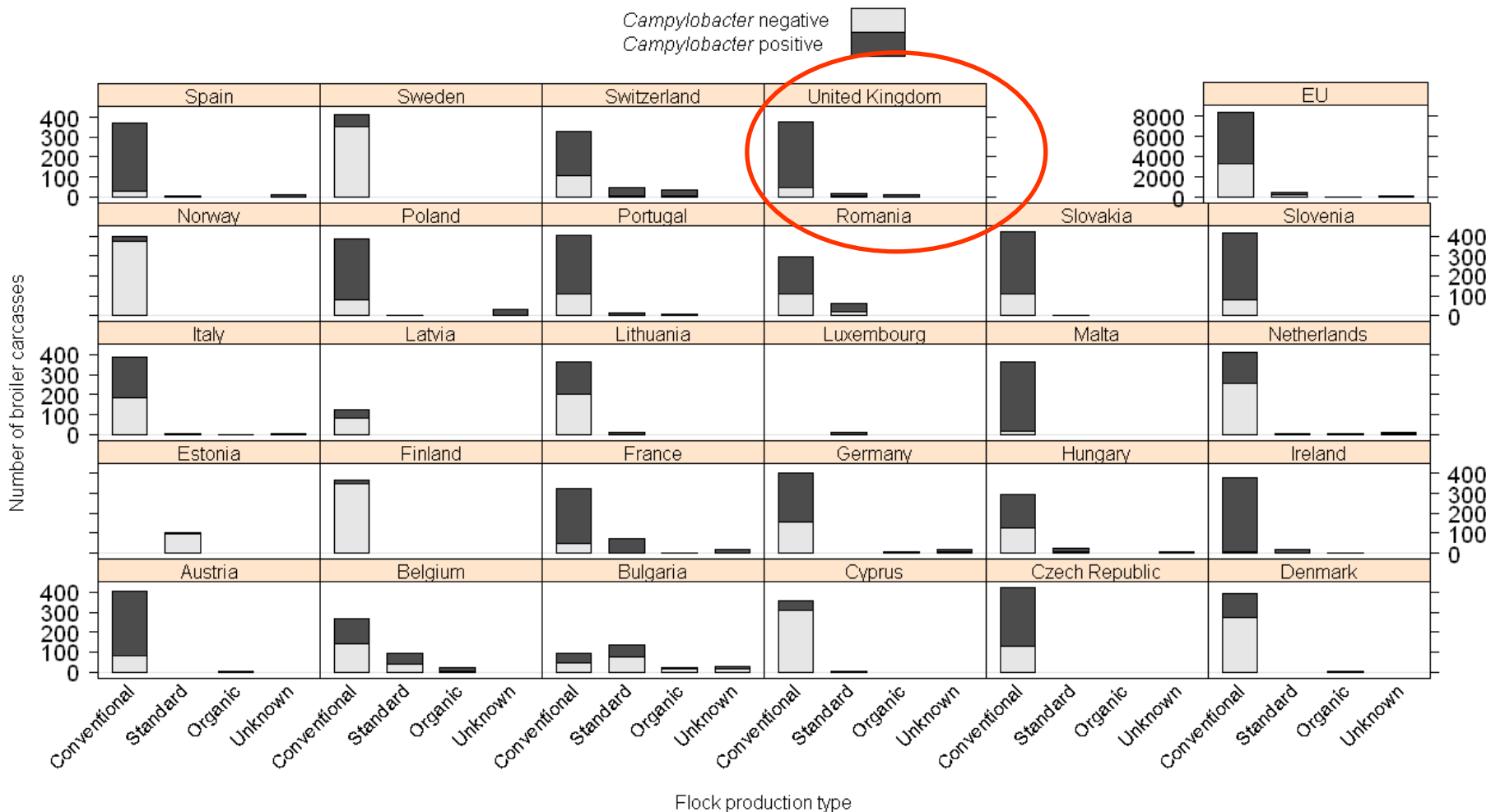
*European Food Safety Authority (EFSA). 2010. Analysis of the baseline survey on the prevalence of Campylobacter in broiler batches and of Campylobacter and Salmonella on broiler carcasses in the EU, 2008, Part A: Campylobacter and Salmonella prevalence estimates. EFSA J. 8:1503.

Prevalence of *Campylobacter*-colonised broiler batches by flock production type in the EU 2008* (standard is standard free-range)



*European Food Safety Authority (EFSA). 2010b. Analysis of the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses, in the EU, 2008; Part B: Analysis of factors associated with *Campylobacter* colonisation of broiler batches and with *Campylobacter* contamination of broiler carcasses; and investigation of the culture method diagnostic characteristics used to analyse broiler carcass samples. EFSA J. 8:1522.

Estimated frequency counts of *Campylobacter*-positive and -negative broiler carcasses by flock production type 2008*



*European Food Safety Authority (EFSA). 2010b. Analysis of the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses, in the EU, 2008; Part B: Analysis of factors associated with *Campylobacter* colonisation of broiler batches and with *Campylobacter* contamination of broiler carcasses; and investigation of the culture method diagnostic characteristics used to analyse broiler carcass samples. EFSA J. 8:1522.

Prevalence of *Campylobacter* in relation to broiler rearing system



Conventional housed flocks	Free range flocks	Organic flocks	Location of flocks	Reference
22/40 (55%)	19/20 (95%)	21/21 (100%)	UK	Allen <i>et al.</i> , 2011
29/79 (37%)	- ^a	22/22 (100%)	Denmark	Heuer <i>et al.</i> , 2001
3/11 (27%)	-	7/9 (78%)	Belgium	Van Overbeke <i>et al.</i> , 2006
-	12/18 (67%)	-	Belgium	Vandeplas <i>et al.</i> , 2010
230/403 (57%)	50/62 ^b (80%)	-	France	Avrain 2001
-	52/73 (71%)	-	France	Huneau-Salaün <i>et al.</i> , 2007
-	(77%)	-	France	Rivoal <i>et al.</i> 1999
-	46/60 (77%)	-	Spain	Esteban <i>et al.</i> 2008
51/125 (40%)	12/19 ^c (63%)		Germany	Näther <i>et al.</i> 2009

^aNo data presented.

^bThese flocks were the “Label Rouge” type.

^cCombined data for flocks from 7 free-range and 3 organic farms.

Colonisation of broilers with or without access to range (I)*

- No significant difference found in number of campylobacter cells carried in chickens reared in different production systems (\log_{10} cfu per g caecal contents reported was 6.5 for organic, 6.7 for free-range and 6.2 for conventional)
- On average organic birds were colonised ~ on day 14 while free-range birds were colonised ~ on day 32 (about when they were given access pasture)

*Allen et al. 2011

Colonisation of broilers with or without access to range (II)*

- Free-range flocks colonised later possibly due to better biosecurity, longer cleaning up period between flocks and same house throughout rearing
- Campylobacters could be isolated from pasture land 24 days after the chickens were removed
- In summary, husbandry/biosecurity (e.g. time between flocks (5 weeks for free-range), same housing, staggered chick intake, multi-age) important

*Allen et al. 2011

Antimicrobial resistance in broiler production systems



- Factors affecting prevalence of drug resistant bacteria include drug usage, husbandry, extent of exposure to MDR bacteria and disease prevalence
- Campylobacters isolated from standard chicken were more likely to be resistant to ciprofloxacin than campylobacters isolated from organic chicken in a recent review (Young et al. 2009)
- In a US study erythromycin resistance was also more prevalent in isolates from conventional compared to isolates obtained from organic chickens
- Higher prevalence of MDR salmonellas reported from conventional compared to organic chicken

Conclusions (I)



- The evidence suggests that replacing conventional cages with non-cage systems is unlikely to result in an increase in *Salmonella* infections or shedding in layers
- Factors including type and age of housing/infrastructure, flock size and biosecurity are important

Conclusions (II)



- Evidence suggests that free-range and organic broilers are more likely to be positive for *Campylobacter* at slaughter in comparison with conventionally reared broilers
- No evidence to suggest that free-range and organic broilers are more likely to be colonised by *Salmonella* than conventionally reared broilers
- There is evidence suggesting antibiotic resistant human pathogens are more commonly isolated from conventionally reared compared to organic or free-range broilers

Thank you for listening
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