

Mutual Effects of the Swiss *Salmonella enteritidis*-Control Programme for Layers: a Success Story

Richard K. Hoop

National Reference Center for Poultry diseases, Institute of Veterinary Bacteriology, Winterthurerstr. 270, 8057 Zurich, Switzerland

* Corresponding author: rhoop@vetbakt.uzh.ch

Abbreviated title: *Salmonella enteritidis* control of Swiss egg production

Summary

With The Swiss control programme for *Salmonella* (SE) *enteritidis* started in 1994. The Swiss Zoonosis Order introduced mandatory monitoring of chicks, faeces, hatchery material, blood and egg yolk to identify infected layer breeder and layer flocks. Other measures such as additional voluntary monitoring, increased hygiene on farms and use of heat-treated feed helped to prevent the spread of SE. In the last ten years the number of reported infections due to SE in layer flocks and human cases has fallen under the level before the onset of SE-infections in Swiss laying flocks. In parallel a significant decrease of infections with other *Salmonella* serotypes was observed in egg production.

Keywords: Monitoring, *Salmonella enteritidis*, laying hen, Switzerland

Introduction

In the 1980ies infections with *Salmonella enteritidis* in man have increased significantly in industrialized countries (Rodrigue et al., 1990). A strong correlation with the consumption of raw or lightly cooked eggs and egg products was established in trace-back studies (Stevens et al., 1989). Subsequently, *S. enteritidis*-infected laying flocks were detected in many countries (Ebel et al., 1992; Giessen et al., 2006; Li et al., 2007). In Switzerland, the first cases of infected breeder and layer flocks were reported in 1989 (Hoop & Pospischil, 1993). Testing different measures to control *S. enteritidis* in layers led to the conclusion that a mandatory control programme was the best option. The Swiss *Salmonella enteritidis* (SE) control programme for laying hens - introduced in 1994 - is based on regular monitoring of all stages of egg production. Infected flocks are culled.

Material and Methods

Samples from different stages of egg production were collected and tested for *Salmonella* using recommended cultural procedures. The material submitted to the laboratory is listed in table 1.

Table 1: Compulsory monitoring for *S. enteritidis* in breeder and laying flocks with more than 50 birds according to the Swiss Zoonosis Order

production	age	material
layer breeder	week 1 - 3	weekly mortality (min. 20)
	week 5	60 faecal samples
	week 15 - 18	60 faecal samples; 0.5 % blood samples (min. 20)
	every 8 weeks	60 faecal samples; 0.5 % blood samples (min. 20)
hatchery (> 1000 egg places)	every hatch	chick layer, dust and meconium from 250 chicks, dead-in-shells
layer	week 1 - 3	weekly mortality (min. 20)
	week 5	60 faecal samples
	week 15 - 18	60 faecal samples; 0.5 % blood samples (min. 20)
	every 15 weeks	1 pair of socks or 2 drag swabs <i>or</i> 0.5 % blood samples (min. 20)

Liver, caecal contents and yolk from 10 chicks were pooled and homogenized. All material was incubated in buffered peptone water (1:10; 37°C; 18-24h), followed by enrichment in tetrathionate broth (1:10; 37°C; 18-24h) and consecutive plating on selective media (brilliant green agar, BGA; Xylose lysine tergitol 4, XLT4; Oxoid Salmonella chromogenic medium, OSCM) (37°C; 18-24h). Suspect colonies (5 per plate) were confirmed biochemically and by agglutination with polyvalent Salmonella-O-antiserum (Difco, BD, USA). Monovalent antiserum against the somatic antigen O 9 (Difco, BD, USA) and swarm agar with monovalent antiserum against flagellar antigen-factor m were used for identification of *S. enteritidis*. All isolated Salmonella were sent to the Swiss National Salmonella Reference Center.

Results

Tables 2 to 4 summarize the results of the monitoring.

Table 2: Number of samples examined and number of *Salmonella* found in egg production (1995 - 2004)

year	samples	<i>Salmonella enteritidis</i>	other <i>Salmonella</i> serotypes
1995	3208	16	17
1996	3405	24	13
1997	2426	7	30
1998	1989	7	9
1999	2807	4	10
2000	2889	9	4
2001	2345	3	8
2002	2302	2	2
2003	2187	3	7
2004	2128	3	0
Total	25686	78 (0.30 %)	100 (0.39 %)

178 isolates (0.7 %) were cultured from a total of 25'686 samples. None of the samples harboured two or more *Salmonella* serotypes. 174 isolates were from inland, 4 from imported poultry flocks. *Salmonella* isolates other than SE were never isolated from internal organs other than intestinal contents. 6 x *S. enteritidis*, 2 x *S. hadar* and 1 x *S. livingstone* were found in chicken liners.

Table 3: Serotypes with more than 5 isolations between 1995 and 2004

serotype	isolates
<i>S. enteritidis</i>	78
<i>S. hadar</i>	21
<i>S. mbandaka</i>	15
<i>S. typhimurium (vaccine strain)</i>	14
<i>S. agona</i>	10
<i>S. heidelberg</i>	6
<i>S. typhimurium</i>	6

Table 4: Human and avian SE-cases 1995 – 2004

year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Human: SE-rate/100'000 inhabitants	70.8	55.0	51.0	42.1	38.9	34.4	36.9	34.3	30.5	25.9
Poultry: infected laying flocks	16	24	7	7	4	9	3	2	3	3

Discussion

The success of the SE control programme is documented by an ongoing decrease of reported avian and human SE-cases. In parallel to SE a reduction of infections by other *Salmonella* serotypes has been observed during the monitoring period. However, this improvement was not only achieved by the strict surveillance of laying birds but also through additional measures such as the refrigeration of eggs older than 10 days at sale point and the use of pasteurized eggs in catering for groups at risk (e.g. in nursery homes, hospitals).

The Swiss control policy aims to stop both routes of infection with *S. enteritidis*. The monitoring of live imported layer breeders during the 15-week-quarantine identifies infected flocks and prevents the vertical transmission of *S. enteritidis* to day-old laying chicks. Various routes of horizontal transmission were monitored and improved. Disinfection control showed that 60 % of the sanitized houses were still contaminated with *S. enteritidis* and confirmed similar observations from other countries (Davies & Wray, 1995; Kinde et al., 2004). Mainly old buildings on multiple age farms contribute to this unsatisfactory situation. Increasing use of heat- and acid-treated feed during rearing and egg production reduced the prevalence of *Salmonella* spp. in this source. The effort to produce *Salmonella*-free feedstuffs in mills with a HACCP-concept for *Salmonella* (Maciorowski et al., 2004) as well as improvement of hygienic standards on farms support the efforts to maintain *Salmonella*-free layer flocks.

Various other measures recommended in the literature (Gast, 2007) were tested and discussed as alternatives to avoid the costs of eradication. Chemotherapy of infected chicks, pullets and laying hens with enrofloxacin was not effective. Inactivated *S. enteritidis*-vaccines and live avirulent *S. typhimurium*-vaccines were used with mutual success although other European countries reported a successful vaccination policy (van der Zee & de Boer, 1999; Cogan & Humphrey, 2003). Pasteurisation of eggs from infected flocks was no alternative due to economic reasons.

References

- COGAN T.A., HUMPHREY T.J. (2003) *The rise and fall of Salmonella Enteritidis in the UK. Journal of Applied Microbiology* 94: 114-119.
- DAVIES R. & WRAY C. (1995) *Observations on Disinfection Regimens Used on Salmonella enteritidis Infected Poultry Units. Poultry Science* 74: 638-643.
- EBEL E.D., DAVID M.J. & MASON J. (1992) *Occurrence of Salmonella enteritidis in the U.S. commercial egg industry: report on a national spent hen survey. Avian Diseases* 36:646-654.
- GAST R.K. (2007) *Serotype-Specific and Serotype-Independent Strategies for Preharvest Control of Food-Borne Salmonella in Poultry. Avian Diseases* 51: 817-828.
- GIESSEN A.W. Van den, BOUWKNEGT M., DAM-DEISZ W.D.C., PELT Van W., WANNET W.J.B., VISSER G. (2006) *Surveillance of Salmonella spp. and Campylobacter spp. in poultry production flocks in The Netherlands. Epidemiology & Infection* 134: 1266-1275.
- HOOP R.K. & POSPISCHIL A. (1993) *Bacteriological, serological, histological and immuno-histochemical findings in laying hens with naturally acquired Salmonella enteritidis phage type 4 infection. Veterinary Record* 133: 391-393.
- KINDE H., CASTELLAN D.M., KASS P.H., ARDANS A., CUTLER G., BREITMEYER R.E., BELL D.D., ERNST R.A., KERR D.C., LITTLE H.E., WILLOUGHBY D., RIEMANN H.P., SNOWDON J.A., KUNEY D.R. (2004) *The Occurrence and Distribution of Salmonella enteritidis and Other Servars on California Egg Laying Premises: A Comparison of Two Sampling Methods and Two Culturing Techniques. Avian Diseases* 48: 590-594.
- LI X., PAYNE J.B., SANTOS F.B., LEVINE J.F., ANDERSON K.E., SHELDON B.W. (2007) *Salmonella Populations and Prevalence in Layer Feces from Commercial Hig-Rise Houses and Characterization of the Salmonella Isolates and Pulse Field Gel Electrophoresis. Poultry Science* 86: 591-597.
- MACIOROWSKI K.G., JONES F.T., PILLAI S.D., RICKE S.C. (2004) *Incidence, sources, and control of foodborne Salmonella spp. in poultry feeds. World's Poultry Science Association Journal* 60: 446-457.
- RODRIGUE D.C., TAUXE R.V. & ROWE B. (1990) *International increase in Salmonella enteritidis: A new pandemic? Epidemiology & Infection* 105: 21-27.
- STEVENS A., JOSEPH C., BRUCE J., FENTON D., O'MAHONY M., CUNNINGHAM D., O'CONNOR B. & ROWE B. (1989) *A large outbreak of Salmonella enteritidis phage type 4 associated with eggs from overseas. Epidemiology & Infection* 103: 425-433.
- ZEE Van der H., de BOER E. (1999) *Monitoring poultry production. Tijdschrift voor Diergeneeskunde* 124: 265-266.