Enhancing animal health security and food safety in organic livestock production

Proceedings of the 3rd SAFO Workshop
16-18 September 2004, Falenty, Poland

Edited by
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SAFO Sustaining Animal Health and Food Safety in Organic Farming
A European Commission funded Concerted Action Project

Sustaining Animal Health and Food Safety in Organic Farming (SAFO)

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Edited by:	Malla Hovi, Jan Zastawny and Susanne Padel
Publication date:	January 2005
Printed in:	The University of Reading
ISBN:	07049 9850 5

Salmonella and campylobacter in organic egg production – with special reference to the Finnish situation

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Introduction

Microbial food safety is a major public health issues in most developed countries. Food-borne microbial infections have had an increasing trend in many western European countries in spite of preventive efforts and economic inputs in the field. A new zoonosis directive has been adopted in 2003. This directive updates and expands the Regulation 92/117/EEC. All EU countries have established national food safety programmes that include, in the first phase, a comprehensive monitoring of relevant food chains for important zoonotic, food-borne pathogens at points where the contamination most probably takes place, as well as monitoring systems for human infectious diseases associated with food-borne transmission.

The most important food-borne, bacterial illnesses in Europe are campylobacteriosis, caused mostly by *Campylobacter jejuni*, and salmonellosis, caused by several salmonella serovars (*Salmonella enterica* serovar. Enteritidis, Typhimurium and some other less common serovars). One of the examples of successful management programmes of food-borne zoonoses has been the decreasing trend of *S. enterica* serovar Enteritidis infections in humans in the UK (Cogan and Humphrey 2003). The main reasons for the decreasing trend have been the implementation of a vaccination programme for laying hens against S. Enteritidis. This was initiated in the mid-990s, together with improved biosecurity programmes at farm level (Anonymous 2001).

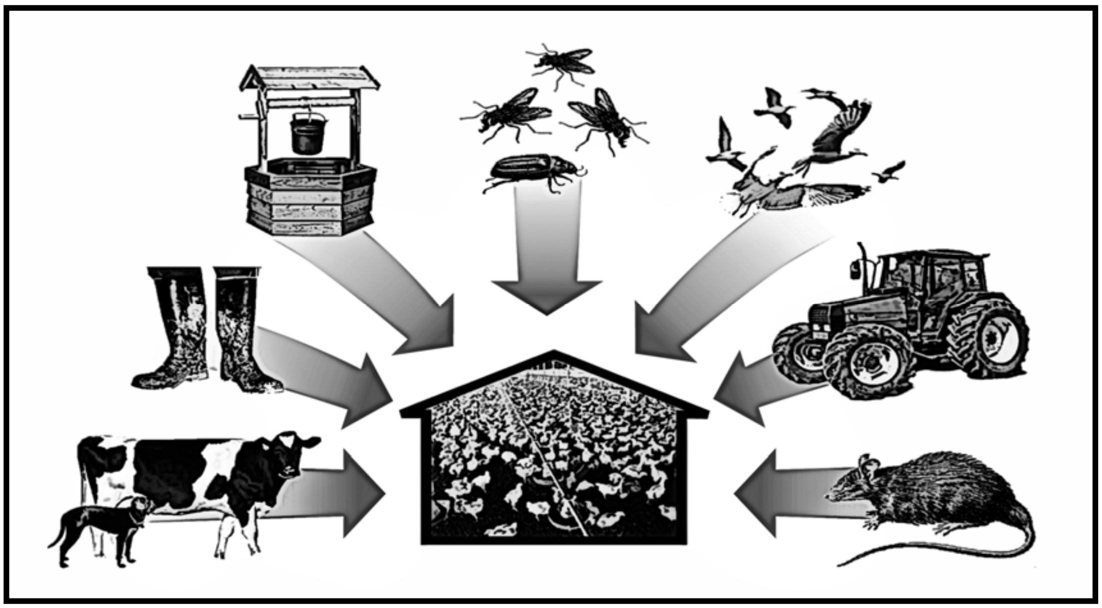
Campylobacter jejuni in animals, especially in poultry

Campylobacter jejuni is a microaerophilic gram-negative organism, which has a large spectrum of hosts in warm blooded animals, including domestic animals, poultry and wild birds. Reported human campylobacter infections have been increasing in most western European countries during the second half of 1990s. Several epidemiological studies performed in Europe and USA indicate that handling or exposure to improperly heat-treated chicken meat is a significant risk factor for acquisition of the illness in humans. The reasons for the increase are unknown, but one of the hypotheses has been that the increase is associated with the extensification of poultry systems.

The bacterium colonizes mostly as a commensal in high numbers (10^6 – 10^8 per gram) in the lower gastrointestinal tract of host animal. It is excreted into the outside environment, such as litter. The survival of the bacterium is restricted and depends e.g. on moisture, temperature, pH and UV light. The organism will survive in natural water if temperature is < 10°C for a few days. The infectious dose in experimental inoculations has been shown to be low, tens of organisms for a few days old chickens. A difference in infectivity between strains is also evident. *C. jejuni* seems to be extremely well adapted for colonization in birds. A supporting factor can be the relatively high body temperature of birds, 43-45°C which is close to the optimum growth temperature of the bacterium *in vitro*. When a commercial chicken flock reared in isolated buildings with 10,000 to 30,000 birds became contaminated by campylobacters, the contamination rapidly spreads into the whole flock during a few days. The flock is usually resistant to colonization during the first two weeks of life.

The *C. jejuni* contamination comes, in most cases, from outside of the house (Figure 1). Common sources of contamination are shown to be the boots of a farmer, if appropriate biosecurity measures are not taken. If the chicken house is located close to other farm animals, an increased risk for contamination is evident. Wild birds, e.g. sparrows living at the farm environment, can be important contamination source of the soil around the chicken house by fecal material. Flies seem to be a very important vehicle in transmission of campylobacters from an animal source to chicken houses. Rodent control is also a well recognized biosecurity measure to limit campylobacter contamination.

Figure 1: Potential contamination sources of a chicken flock by *Campylobacter jejuni*



Campylobacter contamination within a flock can, in the first stage, be limited into a few birds that come first into contact with the bacterium. The contamination, however, easily spreads within the flock by faecal-oral route.

As chicken flocks are easily contaminated by campylobacters from several potential sources during the rearing period, a high level of biosecurity is required for prevention of contamination. The high susceptibility of chicken farming for campylobacter contamination is reflected by high number of campylobacter positive flocks reported in several European countries: 50 to 100% of the flocks are positive. The prevalence of campylobacter positive poultry flocks follows a clear seasonal pattern, especially in the northern Europe. The highest level of positive flocks are found in July, August and September. In late autumn, winter, spring and early summer, fewer positive flocks are detected.

Salmonella in poultry

Several salmonella serovars may colonize poultry. S. Gallinarum and S. Pullorum were common in poultry before 1970s. These serovars cause an invasive disease in hens. The most common serovars associated also with human illnesses in poultry are Typhimurium, and Enteritidisis. Infantis and some other serovars can also cause human infections but these infections are less common. Especially S. Enteritidis PT4 has been important in Europe. S. Enteritidis infection in laying hens is asymptomatic and spreads also into oviducts and ovaries, causing contamination of the contents of shell eggs. S. Enteritidis has a range of host animals that spread the infection rapidly. S. Enteritidis and S. Gallinarum have closely related LPS, fimbriae and they belong to same clonal lineage that favors poultry as animal host. Eggs have been shown to be vehicles in human infections. PT4 has been especially successful in spreading through Europe and the USA, but no unique factors explaining its spread have been far identified so far.

Salmonella is controlled in poultry in most of European countries either by an approved control programme (Austria, Finland, France Denmark, Sweden, Ireland and Norway) or by a monitoring scheme based on the sampling procedures in the Zoonosis Directive. Some countries may have their own monitoring scheme (the Netherlands, Belgium). In 2000, virtually no salmonella positive flocks of layer flocks were reported in Finland, Norway and Sweden. In Ireland, 4.5% and, in Denmark, 3.7% of layer flocks were positive, mostly for S. Enteritidis. In Great Britain, a decreasing trend in salmonella positive flocks was seen (European Commission 2001).

Organic laying hens

Hens used for organic egg production have free access to outside environment during the summer months in Finland. Their life span is much longer than that of broiler chickens. As a result, the management system is susceptible for contamination by zoonotic enteric bacteria, such as campylobacters or salmonellas. The most significant risk in food safety is the contamination of eggs by zoonotic enteropathogens. In case of S. Enteritidis, the contamination is due to infection in the oviducts and ovaria of hens. Prevention is targeted on the spread of infection to farm by high level of biosecurity and vaccination of birds, to increase their immune response. Other salmonellas, e.g. S. Typhimurium, contaminate the shells of the eggs by faecal material after laying. Prevention is targeted to biosecurity and handling eggs at farm. Similarly, the food safety aspect associated with campylobacter colonization in hens is faecal contamination of egg shells by campylobacters. The survival characteristics of salmonellas and campylobacters are, however, not similar. Salmonellas resist e.g. dryness and ambient temperature much better than campylobacters and, for this reason, have more opportunities to survive the egg food chain from stable to table.

In Finland, an ongoing (2003–2005) research project on organic egg production, animal welfare and food safety, funded by the Ministry of Agriculture and Forestry, is examining campylobacter and salmonella contamination of approximately 20 organic layer farms (out of the total of 57 certified layer farms in Finland in 2003). The study includes visits to farms (autumn 2003and spring 2004), a questionnaire dealing with welfare and farm management issues, with potential risks associated with campylobacter colonization.

The size of farms varied from a few hundred to approximately 2,500 hens. In autumn 2003 and spring 2004, a total of 19 and 16 farms were studied, respectively. In autumn 16/19 and in spring 12/16 of the farms were positive for *C. jejuni*. Pulsed-field gel electrophoresis pattern analysis of *Kpn*I digests showed that, on some of the farms, several genotypes existed simultaneously and that some of the genotypes persisted during the whole study period. On some of the farms, entirely new genotypes were detected during spring sampling. None of the samples were positive for salmonella. None of the egg samples from all farms were salmonella positive, and only one egg shell sample was positive for *C.jejuni.* These results reflect data from conventional egg production in Finland where, in all monitoring studies, the number of salmonella positive laying hen flocks or chicken flocks has been very low (virtually non-existent). The flocks that were not campylobacter positive probably reflected low infection pressure in the environment.

In conclusion, adequate biosecurity levels, lowering the number of potential zoonotic infection sources in the vicinity of hen houses and vaccination of hens against S. Enteritidis are available tools to decrease contamination of organic laying hens by campylobacters or salmonella.

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