Campylobacter and *Salmonella* infections on organic broiler farms

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Abstract

Organic poultry production in the Netherlands is developing. Although consumers assume organic products to be safer and healthier, there are aspects of organic animal husbandry, like access to an outdoor run, that can result in increased risks of food safety problems. The aim of this study was to compare housing and management of organic and conventional broiler farms in the Netherlands and to study the occurrence of *Salmonella* and *Campylobacter* infections on the former. Large differences were found between the two farming systems with respect to mixed or single farming, manure storage, drinking-water system, ventilation, access to an outdoor run, and pest control. From the 31 organic flocks sampled for *Salmonella* and *Campylobacter* in 2003, 13% were positive for *Salmonella* and 35% for *Campylobacter*. Results for the summer period are missing due to an outbreak of avian influenza, so the actual number of flocks infected with *Campylobacter* can be expected to be even higher. *Campylobacter* appears to be the main risk on organic broiler farms, so that it would be interesting to study specific risk factors of infection with this pathogen on these farms.

Additional keywords: food safety, risk factors, outdoor run

Introduction

Organic poultry production in the Netherlands is developing. In 2003 there were 17 organic poultry meat farms with a total production of 200,000 birds and a market share of about 1% of total poultry meat consumption. In the same year there were 91 organic egg farms producing 70 million eggs and a market share of 3.7% of total egg consumption, a share that is still growing (Anon., 2004). Since organic food production does not use synthetic inputs and is free from genetically modified organisms, consumers assume that organic products are safer and healthier. However, there are also aspects of organic animal husbandry, like access to an outdoor run, that can result in increased risks of food safety problems. In the Netherlands, *Campylobacter* (36 cases per 100,000 inhabitants) and *Salmonella* (24 cases per 100,000 inhabitants) are the main bacterial pathogens found in samples from patients with gastroenteritis (Van Pelt *et a*l., 2003). Poultry meat and eggs play an important role in these infections.

In egg production, *Salmonella enteritidis* was the main problem but the number of infections decreased when vaccination of laying hens was started (Cogan & Humphrey, 2003). Risk factors for *Salmonella* infections in laying hens are poor rodent control and a poor standard of cleaning and disinfection (Davies & Breslin, 2003). *Campylobacter* is found in laying hens too, but is less easily transferred to the chicken egg (Doyle, 1984). In poultry meat production both *Salmonella* and *Campylobacter* can cause food safety problems. In most studies the incidence of *Campylobacter* is higher and that of Salmonella lower on organic than on conventional broiler farms (Heuer *et al*., 2001, Wolf-Reuter *et al*., 2002). Recently, the Dutch consumer association studied food safety of poultry meat at retailer level. No statistically significant differences were found between organic and conventional meat. *Salmonella* was found in 4% of the organic meat and 8% of the conventional meat, whereas 49% of the organic and 43% of the conventional meat was infected with *Campylobacter* (Kramer, 2003).

Organic broiler husbandry is very different from the conventional system, especially because in organic production systems the birds must have access to an outdoor run. Figure 1 shows the possible transmission routes for *Campylobacter* on convention-

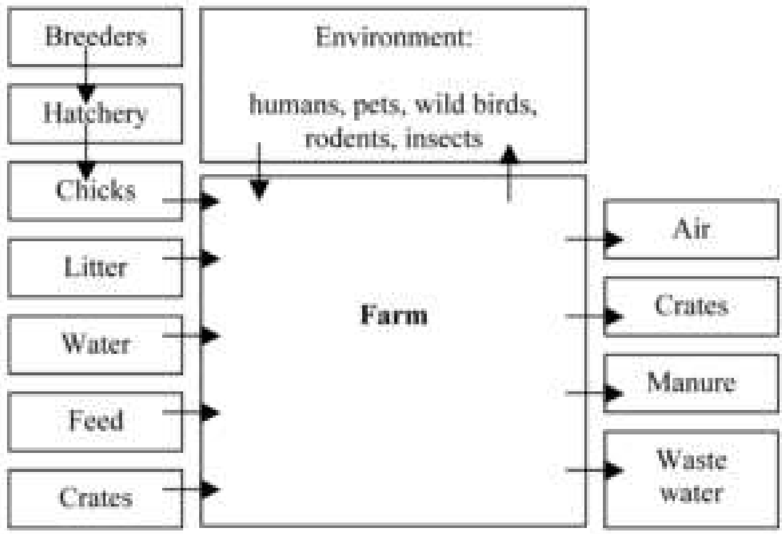

Figure 1. Transmission routes of *Campylobacter* on conventional broiler farms. Source: Veldkamp & Bokma (2004).

al farms (Jacobs-Reitsma *et al.*, 1995; Veldkamp & Bokma-Bakker, 2004). The risk of vertical transmission from the broiler breeders to the eggs in the hatchery and to the one-day-old chicks is small. The other transmission routes shown in Figure 1 result in the following risk factors for *Campylobacter* contamination on conventional farms (Veldkamp & Bokma-Bakker, 2004):

1. Contact with rodents, insects, wild birds and pets;
2. Crates and other materials coming in and going out of the farm;
3. A poor hygiene protocol for visitors;
4. An open drinking-water system and no regular control of water quality;
5. Feeding by-products (for instance wheat from own farm);
6. Litter (straw may be infected with faeces from wild birds);
7. Broilers within the same house (horizontal transmission);
8. Manure (vehicles moving between farms);
9. Dead birds (cannibalism, removal with wheelbarrow);
10. Waste water (environment, surface water).

On organic broiler farms there is more contact with the environment than on conventional farms. Access to the outdoor run increases the risk of poultry becoming infected with *Salmonella* and *Campylobacter* through contact in the outdoor run with wild birds and other animals and with their faeces.

Van Der Hulst-Van Arkel et al. (2004) studied *Salmonella* and *Campylobacter* contamination on organic farms in the Netherlands in 2001 and 2002 (Table 1). In these two years, *Salmonella* contamination in the organic broiler flocks was 5 and 7%,

Table 1. *Salmonella* and *Campylobacter* contamination in organic broiler flocks in 2001 and 2002 (Source: Van Der Hulst-Van Arkel, 2004).

Year and period	Total number of flocks	*Salmonella*		*Campylobacter*	
		No. of flocks	%	No. of flocks	%
2001					
1st quarter	23	1	4	10	43
2nd quarter	26	1	4	8	31
3rd quarter	23	1	4	16	69
4th quarter	26	2	8	22	85
Total 2001	98	5	5	56	57
2002					
1st quarter	24	3	13	10	42
2nd quarter	39	1	3	26	67
3rd quarter	21	1	5	17	81
4th quarter	20	2	10	15	75
Total 2002	104	7	7	68	65

respectively, whereas for *Campylobacter* contamination the percentages were 57 and 65. These results were based on sampling of manure and caecal droppings at 73 days of age, and caecal content at slaughter.

The aim of our study was to compare housing and management of organic and conventional broiler farms and to study the occurrence of *Salmonella* and *Campylobacter* infections on the former.

Materials and methods

Questionnaire

In February 2003 a detailed questionnaire was filled out together with the farmer on 13 organic and 10 conventional broiler farms. The following topics were included: information about the farm and its environment, the birds, the litter, the growing period of the broilers, the feed, the drinking-water system, the climate, health problems, hygiene, and access to an outdoor run.

Salmonella and *Campylobacter*

Between January and December 2003, samples were collected on the 13 organic farms to study the prevalence of *Salmonella* and *Campylobacter*. Due to an outbreak of avian influenza in the Netherlands sampling and farm visits had to be discontinued from April until September 2003. The crates, floor cover, the house itself and the outdoor run were sampled just before the new flock arrived. During the growing period, the feed, the drinking water, the outdoor run (days 1, 50, 74), and the fresh caecal droppings (days 1, 17, 35, 50, 74) were sampled. At the slaughterhouse, samples included caeca content, breast skin and end products (meat). *Salmonella* and *Campylobacter* were determined according to the Branch methods as formulated by the Dutch Product Boards for Livestock, Meat and Eggs (Anon., 2000). In brief, *Salmonella* was isolated on semi-solid MSRV-agar (1 day at 42 °C), after pre-enrichment in BPW for 1 day at 37 °C. *Campylobacter* isolation was on *Campylobacter*-selective mCCDA agar (2 days micro aerobically at 42 °C). Fresh caecal samples were directly streaked onto mCCDA. All other sample types were enriched in selective enrichment broth mCCDB for 1 day at 42 °C before plating onto mCCDA. If *Salmonella* was isolated, the strains were further classified by serotyping. Identification of *Campylobacter jejuni* and *C. coli* was performed using a multiplex PCR assay (Van Der Giessen *et al.*, 1998). The DNA-extraction method using Chelex 100 as described by Engberg *et al.* (2000) was used. With the multiplex PCR the *Campylobacter* could be identified based upon the length of the amplification product.

Results

Questionnaire

The results from the questionnaires show large differences between conventional and organic broiler farms (Table 2).

Table 2. Characteristics of conventional and organic broiler farms; results from questionnaire.

Characteristic	Conventional farms (n = 10)		Organic farms (n = 13)	
	Reply	%	Reply	%
Farming system	mixed	50	animals only	38
Manure storage	no	100	yes	62
Water system	nipple drinkers	100	open drinkers	62
Water quality	control	70	no control	77
Ventilation	mechanical	100	natural	100
Outdoor run	no	100	yes	100

Fifty percent of the conventional farmers had mixed farms with arable farming (crops, bulbs, plants) as other farming activity, whereas 38% of the organic farmers had mixed farms with animal farming (pigs, cattle, laying hens or turkeys) as other farming activity. Manure storage is not much used on conventional farms, but is often found on organic farms. All conventional farms used nipple drinkers and most of them also controlled water quality, whereas most organic farms used open drinkers and did not control water quality. On conventional farms forced ventilation is used and on organic farms ventilation is natural. Organic farms have an outdoor run whereas conventional farms do not.

Furthermore, there were differences in pest control measures (Table 3). Conventional farms mainly used chemicals against mice, rats and darkling beetles, whereas organic farms used chemicals, cats or traps against the two rodents but no chemicals

Table 3. Differences in pest control measures between conventional and organic broiler farms.

Pest	Control measure	Conventional (n = 10)	Organic (n = 13)
		(%)	(%)
Mice/rats	Chemical	80	38
	Cat	0	23
	Traps	0	8
	Not specified	20	54
Darkling beetles	Chemical	50	0

were used against darkling beetles. The presence of darkling beetles in the house has been shown to increase the risk of *Campylobacter* contamination (Refregier-Petton *et al.*, 2001).

Salmonella and *Campylobacter*

A total of 31 flocks were sampled to assess the prevalence of *Salmonella* and *Campylobacter*. As a result of the outbreak of avian influenza sampling was paused from April until September 2003, so the results were limited. Out of 31 flocks 4 were positive for *Salmonella* (13%) and 11 for *Campylobacter* (35%). In two of these 11 flocks, no *Campylobacter* was found in the samples taken at 10 weeks of age.

Campylobacter strains

Of the *Campylobacter* strains found in the period 2001–2003 in organic broilers, and that were typed with the multiplex PCR technique, 27% was *C. jejuni* and 73% *C. coli*. For conventional broilers these figures were about 70 and 30, respectively.

Discussion

The results from the questionnaire showed large differences in housing, management and pest control between organic and conventional broiler farms. Of the organic flocks sampled in 2003 for *Salmonella* and *Campylobacter*, 13% were positive for *Salmonella* and 35% for *Campylobacter*. In 2001 and 2002, the prevalence of *Salmonella* was 5% and 7% and that of *Campylobacter* 57% and 65%, respectively (Van Der Hulst-Van Arkel *et al.*, 2004). The lower percentage of *Campylobacter* in 2003 may be explained by the absence of samples from the summer period, due to the outbreak of avian influenza. During the summer period often a peak is found in infections with *Campylobacter* (Jacobs-Reitsma *et al.*, 1994). We have no explanation for the higher incidence of *Salmonella* on organic broiler farms in 2003, compared with 2001 and 2002. Perhaps this is also caused by the fewer data.

Campylobacter appears to be the main risk on organic broiler farms. It would be interesting to study specific risk factors of infection with *Campylobacter* on organic farms. Veldkamp & Bokma-Bakker (2004) stated that contact with other animals and an open drinking-water system are risk factors for infection with *Campylobacter*. Based on the results from the questionnaire, showing that organic broiler farms use outdoor runs and open drinking-water systems, it can be concluded that these farms run an increased risk of infection with *Campylobacter*.

A difference was found in *Campylobacter* strains between organic and conventional broiler farms. *C. coli* appeared to be the predominant species on organic farms, whereas only 7% of the cases of *Campylobacter*-related illness in humans are caused by this species. Heuer *et al.* (2001), on the other hand, studied the occurrence of the different species in organic, conventional and extensive indoor flocks but found no difference between the systems. In their study *C. jejuni* was the predominant species in all three systems. It remains unclear what the explanation is for the difference between organic and conventional farms found in our study. It may be that the different contact structure affects infection with *Campylobacter*. If, for instance, an organic farmer keeps pigs as additional farm activity he may run an increased risk of infection with *C. coli*, as pigs are frequently infected with this species (Payot *et al.*, 2004). The risk of spreading *Campylobacter* and *Salmonella* from other animals on the farm to the broiler flock, or between broiler flocks can be reduced by applying hygiene measures, like changing footwear when entering a broiler house and washing hands before tending the flocks (Van De Giessen *et al.*, 1998).

In conclusion, *Campylobacter* contamination being the main risk factor for organic broilers, the specific risk factors for *Campylobacter* contamination on organic farms need further study.

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