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Sources of *Salmonella* contamination during broiler production in Eastern Spain

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ABSTRACT

Prevention of *Salmonella* contamination of poultry products requires detailed knowledge of the main sources associated with its presence in the production system. The aims of this study were to determine the main sources of *Salmonella* contamination in broiler production during growing, to assess the risk factors for *Salmonella* contamination at the end of the rearing period and to determine the main serovars involved in broiler production systems in Eastern Spain. A total of 65 different broiler houses from different farms were sampled. Each house was sampled at different times during the rearing period. First, when the previous flock was taken to the slaughterhouse, samples of dust, surfaces and previous flock faeces were collected. After cleaning and disinfection (C&D), samples of dust and surfaces were also taken. On the first day of rearing, samples of water, bedding, farming boots, meconiums, delivery-box liners and feed were collected. During rearing, feed samples were taken directly from the truck and from feeders. On slaughter day, samples of dust, surfaces, water, feed and faeces were also collected. Finally, two days after slaughter, carriers (rodents, flies and beetles) were trapped. All samples collected were analysed according to ISO 6579:2002 (Annex D) and positive samples were serotyped in accordance with Kauffman–White–Le–Minor technique. Our results showed that all different types of samples collected were contaminated with *Salmonella* (prevalence ranged between 1.5% and 38.6%). The most contaminated samples related with poultry production were: delivery-box liners (32.0%), faeces samples (31.2%), dust samples (25.0%), farming boots (19.7%) and feed from feeders (16.0%). However, the most important risk factors for *Salmonella* contamination of the flocks at the end of the rearing period were *Salmonella* status of the house after cleaning and disinfection, *Salmonella* status of day-old chick flocks and feed from feeders. Twenty-one different serovars were isolated from the samples analysed. The most prevalent were in decreasing order: *Salmonella* Enteritidis (52.9%), *S.* Hadar (17.8%), *S.* Virchow (8.9%) and *S.* Ohio (5.4%). The study suggested that there are many sources for *Salmonella* contamination and persistence in broiler production. Hence, the whole production chain needs to be controlled to eradicate the bacteria from primary production.

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Table 1
Sampling visits and samples collected during the lifespan of each broiler flock.

Before C&D	After C&D	First day of rearing	During rearing	Slaughter day	Two days after slaughter
Dust	Dust	Water tank	Feed from truck	Dust	Flies
Surfaces	Surfaces	Water drinkers	(Age 2, 3 and 4)	Surfaces	Rodents
P.F.F.		Bedding	Feed from feeders	Water tank	Bettles
		Faeces	(Age 1, 2 and 3)	Water drinkers	
		Farmer boots	Carrier trapping	Faeces	
		Meconiums	(Flies)	Feed from feeders	
		D.B.L.		(Age 4)	
		Feed from truck (Age 1)		Carrier trapping	
				(Rodents and bettles)	

C&D: cleaning and disinfection, P.F.F.: previous flock faeces, D.B.L.: delivery-box liners, Age 1: feed delivered first 14 days of rearing, Age 2: feed delivered from day 14 to day 21, Age 3: feed delivered from day 21 to day 35, age 4: feed delivered from day 35 until slaughter.

1. Introduction

Salmonellosis is an important public health concern associated with food consumption of animal origin (EFSA, 2009). According to Jiménez and Martín (2004), eggs and poultry meat are involved in 75.0% of human salmonellosis outbreaks in Spain, constituting an important threat to public health. According to the European Commission (EC, 2007), in Spain only non-*Salmonella* contaminated broiler meat may be sold for human consumption starting 2011. In recent years, Food Safety has become an important concern for European society and governments, so that many stricter and stronger regulations were imposed throughout the production chain with the aim of guaranteeing and increasing consumer confidence in foodstuffs of animal origin (EC, 2003, 2007).

Many epidemiological studies have reported the wide variety of routes by which *Salmonella* can be disseminated within integrated poultry companies in Europe (Rose et al., 1999, 2000; Heyndrickx et al., 2002; Davies and Breslin, 2003; Namata et al., 2008). Historically, an inadequate cleaning and disinfection has been reported as an important risk for *Salmonella* persistence in poultry houses (Davies and Breslin, 2003; Rose et al., 2003; Gradel et al., 2005; Marin et al., 2009). Moreover, removing rodents and insects during production breaks is also an important factor in *Salmonella* control (Davies and Breslin, 2003; Carrique-Mas et al., 2008). These authors reported that the presence of contaminated carriers, especially rodents, is involved in recontamination of houses after cleaning and disinfection. Rose et al. (2000) suggested that two of the most important risk factors are the *Salmonella* status of the previous flock and day-old chick flocks. Infection in day-old flocks could be vertical from infected breeder flocks or horizontally transmitted during hatching, loading and transport to the farm (Cox et al., 1990; Cason et al., 1994; Chriél et al., 1999) and, at farm level, from the house environment (Rojas et al., 2002; Davies and Wray, 1996).

In addition, Heyndrickx et al. (2002) reported that feed and water in broiler houses are risk factors significantly related to the flock status. The role of feed and feed ingredients in the spread of *Salmonella* through the poultry industry has received a great deal of attention (Bailey et al., 2001). Less than one *Salmonella* per gram of feed has been shown to establish colonization in 1–7 day-old chicks (Waldroup et al., 1992). Livestock drinking water has also been considered as a major source of exposure of foodborne pathogens (LeJeune et al., 2001).

Other factors, such as flock size, number of houses located on the farm and the annual number of flocks produced within a house have been reported as posing no significant risk of *Salmonella* contamination (Chriél et al., 1999).

The objectives of this study were (i) to determine the main sources for *Salmonella* contamination in broiler production, (ii) assess the main risk factors for *Salmonella* contamination of broiler flocks at the end of the rearing period and (iii) determine the main serovars involved in poultry production systems in Eastern Spain.

2. Material and methods

2.1. Study sample

Over two years, 65 commercial broiler farms from the Valencia Region were sampled (East Spain). The number of farms analysed provides this study with a 95% confidence level and a power of 80%. The sample selection was done using a commercially available software for veterinary epidemiology (Win episcope®2.0). Only one flock was studied on each farm. These farms belong to five companies, which provide the majority of the poultry slaughtered in the Valencia Region. The farms were selected to represent market share of the five companies. To participate in the study, farms had to be commercial broiler farms. The farms locations and the day of placing the chicks were provided by the companies. All the farm owners were willing to cooperate during the lifespan of the flock.

2.2. Moment of sampling for Salmonella in broiler flocks

Each farm was visited and sampled at different moments during the rearing period (Table 1). The first visit occurred when the previous flock left for the slaughterhouse (before cleaning and disinfection, C&D). The next visit was after C&D. Then, the farm was visited again just before placing day-old chicks (Day 1). During the rearing period, each farm was visited when a different feed truck arrived at the farm. Finally, last visits were on slaughter day, between day 42 and day 49 of rearing (common fattening period) and two days after slaughter.