



Prevalence of and examination of exposure factors for *Salmonella* on commercial egg-laying farms in Barbados

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ABSTRACT

During January–March 2009, an outbreak of *Salmonella* was diagnosed in four commercial egg-laying farms in Barbados. During the outbreak, 511 layers died while 3257 layers were voluntarily culled from one affected farm. *Salmonella* ser Enteritidis was identified in avian tissues (ovaries, liver, and uterus), and egg samples submitted to the Ministry of Agriculture, Food, Fisheries, and Water Resource Management (MAFFW) Veterinary Services (VS) Laboratory by managers of the affected farms. As a result of this outbreak, MAFFW VS conducted a survey to investigate the prevalence of *Salmonella* on commercial egg-laying farms in Barbados. In addition, the relationships between farm-level exposure factors and diagnosis of *Salmonella* were examined. This paper describes the results of this survey.

Nineteen of 26 farms (73%; 95% CI = 56–90%) were classified as positive for *Salmonella*. The odds of testing positive for *Salmonella* were 10 times higher in large farms, compared to small farms (OR = 10.80; 95% CI = 1.01, 115.10; $p = 0.04$). More small farms (8/11) cleaned and disinfected poultry facilities quarterly or more often than large farms did (1/10) ($p < 0.01$). Prevalence of *Salmonella* in commercial egg-laying farms in Barbados is high. *Salmonella* ser Enteritidis was the most common serotype identified in study farms, and this is a public health issue of concern. This is the first prevalence survey of *Salmonella* in egg-laying farms in Barbados. Study results can be used as a baseline for future control programmes aimed at reducing the prevalence of *Salmonella* in egg-laying farms in the country.

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1. Introduction

Salmonellosis in poultry and humans is a public health issue of concern worldwide. Cases of *Salmonella* ser Enteritidis infection in human beings are thought to be associated with the consumption of contaminated and insufficiently cooked egg products (Snow et al., 2010; Kessel et al., 2001; Hogue et al., 1997). In some countries, statutory monitoring

and control of *Salmonella* ser Enteritidis and *Salmonella* ser Typhimurium, and the use of vaccines against these two pathogens in commercial breeding and egg-laying farms have played a major role in the control of *Salmonella* in poultry flocks (Snow et al., 2010; Davies and Breslin, 2003).

In Barbados, a compulsory notification system exists for salmonellosis in humans. A total of 1312 human cases of salmonellosis were confirmed during 2000–2010 (Ministry of Health, Barbados, 2010). The two most common *Salmonella* serotypes identified were Typhimurium (365/1312 or 28%) and Enteritidis (164/1312 or 12%). The sources of these infections were not investigated.

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Salmonella monitoring and testing of commercial egg-laying farms in Barbados is not compulsory. Furthermore, standardized prevalence surveys to establish the baseline prevalence and to examine risk factors for *Salmonella* in commercial egg-laying farms have not been conducted.

During January–March 2009, an outbreak of *Salmonella* was diagnosed in four commercial egg-laying farms in Barbados. During the outbreak, 511 layers died on the four farms. One farm went out of business while 3257 layers were voluntarily culled from another affected farm. The two other farms chose to institute enhanced cleaning and disinfection measures, but kept their birds in production. *Salmonella* ser Enteritidis was identified in avian tissues (ovaries, liver, and uterus), and egg samples submitted to the Ministry of Agriculture, Food, Fisheries, and Water Resource Management (MAFFW) Veterinary Services (VS) Laboratory by managers of the affected farms. As a result of this outbreak, MAFFW VS conducted a survey to investigate the prevalence of *Salmonella* on commercial egg-laying farms in Barbados. In addition, the relationships between farm-level exposure factors and diagnosis of *Salmonella* were examined. This paper describes the results of this survey.

2. Methods

2.1. The poultry industry in Barbados

The poultry industry in Barbados is the largest and most profitable livestock sector. Production is primarily for local consumption. In 2010, annual local consumption of poultry meat was estimated at 15 million kg while local production was 14.1 million kg. Local production of table eggs was estimated at 2.2 million kg (Barbados Business, <http://www.businessbarbados.com>; 2011).

In Barbados, hatching eggs (layer, broiler and turkey) are imported from the United States of America and Canada, but some are produced locally. The only breeder flock on the island, which produced broiler hatching eggs, was discontinued in 2012. There are four hatcheries on the island, and two of them export day-old chicks to other countries in the region.

Egg-laying farms in Barbados vary in size from small backyard farms with a few birds producing eggs for household consumption to commercial flocks with approximately 80,000 birds. There are two farms with caged birds, while all others practice floor or free-range production. Bagasse is the bedding of choice for most farmers. There is one local feed manufacturer from which the majority of farmers obtain their feed; however, feed is also imported from Jamaica, St. Vincent, and Trinidad.

2.2. Study population

A total of 35 commercial egg-laying farms registered at the 2 major hatcheries supplying layer chicks in Barbados were considered for inclusion in this study. Ten of the 35 egg-laying farms had received a batch of 1-day-old chicks associated with the outbreak of *Salmonella*; these 10 farms were included in the study because they were part of an

outbreak investigation conducted by MAFFW veterinarians.

Sixteen additional farms were randomly selected from a list of 35 holdings obtained from the 2 major hatcheries. Although the sample of 26 holdings was not random, this sample size was justified by using the following assumptions: (i) population = 35 commercial egg-laying farms; (ii) expected prevalence = 50%; (iii) precision = 10%; (iv) confidence level = 95% (Dohoo et al., 2004). Participation of the 26 farm owners or managers was voluntary.

Vaccination of laying hens against *Salmonella* is not practiced on commercial egg-laying farms in Barbados (MAFFW, 2010).

2.3. Study design

A prevalence survey was formulated and implemented after the outbreak of *Salmonella* was diagnosed in four commercial egg-laying farms in Barbados during January–March 2009. The survey was designed as a cross-sectional study, and it was implemented over 21 months from April 2009 to December 2010. Each farm was sampled once, and every pen on each farm containing layers was sampled. Farms were sampled on Mondays only to accommodate the five days required to culture and confirm *Salmonella* spp. isolates. Only one farm was visited and sampled in a given week to reduce the risk of spreading *Salmonella* and other pathogens from farm to farm, by MAFFW personnel.

2.4. Collection of egg and environmental samples

A protocol for sample collection was formulated and implemented based on procedures recommended by the World Health Organization (1994) and the U.S. Food and Drug Administration Bacteriological Analytical Manual. The protocol was modified according to the willingness of farm owners to provide eggs for testing, and the availability of MAFFW VS Laboratory funds and personnel to conduct testing.

2.4.1. Eggs

On each farm, an attempt was made by the MAFFW VS personnel to collect a total of 30 eggs per pen. The laying period of hens in each pen was not recorded.

2.4.2. Environmental samples – floor pens

On each farm an attempt was made to collect a minimum of 9 environmental samples per pen (faeces, dust, feed, bedding, wooden areas, pen wire, nesting boxes, feeder, drinker). Each faecal sample consisted of fresh pooled faecal material from 10 birds housed in the same pen collected in sterile bags using sterile scoops for each sample. Feed samples consisted of approximately 500 g of feed collected in sterile bags using sterile scoops for each sample. Dust samples were 10–25 g of dust taken from various sites of the pens and placed into sterile bags. Bedding samples consisted of 25 g taken from several sections of the floor and placed into sterile bags. Swab samples consisted of five 10 cm × 10 cm pieces of sterile gauze moistened with sterile buffered peptone water used to swab approximately

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