Introduction

Salmonellosis is one of the most important food borne illnesses across the European Union, with 82,694 confirmed cases and an EU notification rate of 20.4 cases per 100,000 population, reported from 27 member states in 2013. The number of human salmonellosis cases has been declining steadily over the past five years, and it is likely that the decrease in human cases was the result of both the successful implementation of the Salmonella control programmes across the different chicken and turkey production sectors and of several different control measures which were implemented on farms and along the food chain. This review will give an overview over the history of food borne salmonellosis, describe current EU legislation, which has been instrumental in reducing the Salmonella prevalence in poultry production, and discuss other factors which have contributed to the fact that the number of human salmonellosis across the EU is at its lowest level in years.

Human salmonellosis in the past three decades

In the mid to late 1980s, a massive Salmonella epidemic began to emerge in the United Kingdom, and data from other countries around the world indicate, that an increase of S. Enteritidis-cases took place at the same time at least in North America, South America and several countries in Europe. It is not exactly clear how and why S. Enteritidis could cause such an epidemic, but infected eggs clearly played an important role. S. Enteritidis is more skillful than other serovars at colonizing the reproductive tract of laying hens, therefore leading to a higher proportion of eggs being contaminated in the contents compared to infection with other serovars. Infected breeding eggs were an important source of infection for laying hen flocks, which in turn produced infected table eggs. In 1990, the WHO surveillance system suggested that S. Enteritidis had become a predominant serovar in many countries, although different strains were involved in different countries, with phage type 4 being predominant in the United Kingdom and phage types 8 and 13b being predominant in the United States.
In the United Kingdom, a first drop of human cases was seen after the introduction of a vaccine for breeding chickens in 1994, followed by a more substantial decline after the introduction of a vaccine for laying flocks in 1997. Several control measures have been implemented by the poultry industry over the past two decades, which have undoubtedly contributed to a reduction in prevalence of Salmonella-positive chicken flocks. These include vaccination of breeding and laying birds against S. Enteritidis and S. Typhimurium, improved general hygiene and biosecurity, improved pest control, improved control over feed, improved cleaning and disinfection standards and introduction of an all-in-all-out system where possible. A study performed on British laying farms identified these factors to be associated with a reduced risk of S. Enteritidis infection.

Over the past three years, a substantial drop in the number of human salmonellosis cases has been observed throughout the European Union, and figure 1 shows data published by the European Food Safety Authority. Information on Salmonella serovars from cases of human infection was available from 25 member states (MS). As in previous years, the two most commonly reported Salmonella serovars in 2013 were S. Enteritidis and S. Typhimurium, representing 39.5 % and 20.2 %, respectively, of all reported serovars in confirmed human cases (N=73,627). S. Enteritidis continued to decrease, with 4,760 fewer cases reported in the EU in 2013 than in 2012 and with a decrease in confirmed cases of 19.3 % compared with 2011. In the two-year period from 2011 to 2013, cases of S. Typhimurium decreased by 26.0 %. Cases of monophasic S. Typhimurium 1,4,[5],12:i:-, however, increased by 68.8 %, with four additional countries reporting this variant in 2013 compared with 2011 (3rd most common serovar).

Figure 1: Distribution of reported confirmed cases of human salmonellosis in the EU/EEA, 2011-2013, by the 20 most frequent serovars in 2013.


EU legislation

Regulation (EC) No. 2160/2003 and Directive 2003/99/EC formed the basis for the introduction of Salmonella legislation across the European Union, and separate regulations for each production sectors were introduced in the years to follow. Salmonella legislation is currently only targeted at chicken and turkey production above a certain holding size, i.e. small producers are not included, as are producers of other poultry species, such as ducks, geese and game birds. Salmonella surveillance of breeding chickens started in 2007, followed by laying chickens in 2008, broiler chickens in 2009 and turkeys in 2010. Each member state was required to draw up a National Control Programme, and the Competent Authority is responsible for delivering the programme and submitting data to the European Commission on an annual basis. The National Control Programmes are “flock-based”, i.e. the unit to be tested is a flock of poultry. Only the two most prevalent serovars in humans (S. Enteritidis and S. Typhimurium) are regulated in all production sectors, with the exception of chicken breeding flocks, where S. Hadar, S. Virchov and S. Infantis are also regulated to some extent. The programmes are based on both operator sampling and official sampling, which are overseen by the Competent Authority. Proper collection of samples, testing according to ISO 6579 and reporting of positive isolates are essential pillars of the surveillance system.

Whole food chain approach

The National Control Programmes are to be seen in conjunction with other pieces of EU legislation, which ensure that food safety is being achieved not only through controls at the farm level, but also in the slaughterhouse. This “whole food chain approach” includes Regulation (EC) 852/2004 on the “Hygiene of foodstuffs” and Commission Regulation (EC) No. 2073/2005 on “Microbiological criteria for foodstuffs”, which lays down the microbiological criteria for certain micro-organisms and the implementing rules to be complied by food business operators.
How to implement a *Salmonella* surveillance system

In order to implement a functioning *Salmonella* surveillance system, a network of expertise, comprising the Competent Authority, accredited laboratories and a State Veterinary Service to implement restrictions are necessary in each member state. According to Regulation 2160/2003, each member state shall nominate a Competent Authority to oversee the programme. This authority is also responsible for transmitting data to the European Commission on an annual basis and for regular compliance and record checks on farms.

Member states need to establish a National Reference Laboratory; however, other laboratories can also participate in the control programmes, given they have been designated by the Competent Authority, apply quality assurance systems conform to the current ISO standard and regularly participate in collaborative tests. In the United Kingdom, the *Salmonella* surveillance system is the result of a collaborative approach between governmental entities of the four countries: England (Defra - Department for Environment, Food and Rural Affairs); Wales (Welsh Government); Scotland (Scottish Government) and Northern Ireland (DARD - Department of Agriculture and Rural Development).

**Main sources of *Salmonella* on poultry farms**

Infected replacement birds, contaminated equipment and contaminated feed are some of the most common sources of *Salmonella* infection on a poultry farm. Once the infection gets established inside a poultry house and/or the environment, it can be difficult to eliminate, and a great effort is often needed to get a house *Salmonella*-free after a positive flock test. *Salmonella* can become established in rodent populations and other vectors, such as litter beetles or mites. *Salmonella* have been shown to survive for many months both under dry conditions, i.e. in dust in poultry houses, and under wet conditions in the environment. Insufficient cleansing and disinfection are often the reason for carry-over from one crop to the next, as is poor general hygiene and biosecurity. Some serovars are also known to be good biofilm-producers, which enables them to survive long term in feed mills, hatcheries or on farms. Elimination of infection from a poultry house or establishment requires a holistic approach involving several aspects of disease control. The main routes of *Salmonella* introduction on farms are shown in fig. 4.

In member states, where the use of live vaccines is permitted, laboratories must be capable of reliably distinguishing *Salmonella* vaccine strains from field strains when testing samples taken under the National Control Programmes.
Conclusions

Salmonellosis is (still) the second most common food borne illness in the EU, although significant progress has been made by the poultry industry over the past decade to reduce the Salmonella prevalence in chicken flocks. EU legislation has been instrumental in implementing control measures at farm level, and both official and operator sampling are necessary to implement a successful control programme. Vaccination of breeding and laying flocks against S. Enteritidis and S. Typhimurium has also played an important role in eliminating the two most prevalent Salmonella serovars from chicken flocks in many countries and is now a requirement in quality assurance schemes in several member states. Overall, an integrated approach, including vaccination, diagnostic & monitoring, nutritional management, biosecurity, hygiene at all levels of production, pest control and feed control, is necessary to keep the prevalence of Salmonella-infection in poultry flocks at a low level.

Bibliography


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