Controlling Salmonella via the drinking water

New legislation by the European Union aims at reducing Salmonella – the major cause of food-borne outbreaks – on poultry farms. The application of organic acids via drinking water offers a strong and flexible contribution to reduce and maintain low levels of these bacteria.

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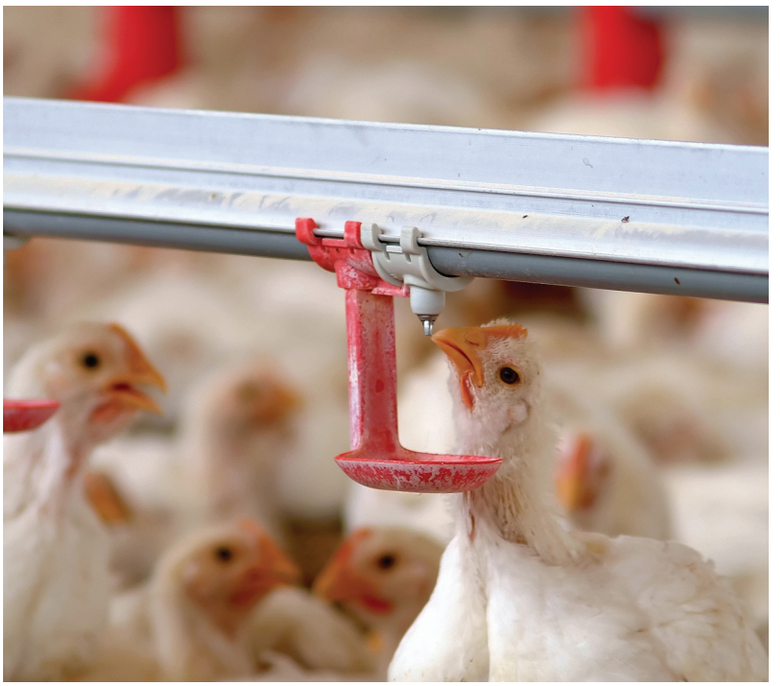
Salmonellosis is one of the most common causes of foodborne disease worldwide. In humans, Salmonella food poisoning typically causes acute gastroenteritis, which is characterised by abdominal cramping, fever and symptoms such diarrhoea. In more serious cases, Salmonella can escape from the intestine and enter into the bloodstream and travel to other organs, leading to more severe consequences. Most Salmonella infections are zoonotic and are transmitted from healthy carrier animals to humans through contaminated food. The main sources of human Salmonella infections are animal-derived products, especially fresh meat products and eggs. The majority of salmonellosis infections are caused by poultry products (European Food Safety Authority, 2007).



The use of organic acids in the drinking water makes dosing flexible and the product is easy to mix with all ingredients in crop, stomach and intestines.

EU legislation

New EU legislation focuses on Salmonella control within the poultry production chain, and is aimed at the reduction of Salmonella-positive flocks and products. The main driver here is financially penalising poultry meat and egg producers who have high levels of Salmonella on the farm. As of 1 January, 2009, egg products are required to be free of Salmonella. Egg producers may not deliver 'table eggs' from Salmonella-positive layer flocks, but need to be sold for industrial processing. A Salmonella-positive flock has a significant impact on the producer's income as industrial eggs have a lower value then table eggs. This further emphasises the importance of Salmonella prevention.

To monitor the Salmonella status of the flocks, laying hen farmers have to analyse their birds (swabs or overshoes) every 15 weeks from 22 weeks of age. Beginning in January 2011, fresh poultry meat products are also required to be free from Salmonella (EC-2160/2003). Products not meeting this criterion may only be sold after treatment as processed food. Furthermore, Salmonella prevalence in broiler and layer flocks must be less than 1% contaminated flocks per country achieved in 2012. This may have a very serious effect on the market situation as national prevalence numbers may be used as an import regulating tool with countries having a high Salmonella prevalence being banned to export to countries with a lower prevalence. However, results of the 2007 European Food Safety Authority survey have shown that prevalence levels are above 20% for the EU average, both in broiler and layer flocks (*Figure 1*). This indicates that serious improvements are necessary in most EU countries in order to produce poultry meat and eggs in line with future legislation.

Salmonella control

Salmonella is a Gram-negative facultative rod-shaped bacterium in the same proteobacterial family as E. coli, the family Enterobacteriaceae. The Salmonella family includes over 2,300 serotypes of bacteria. These single-celled organisms are too small to be seen without a microscope. *Salmonella Enteritidis* and *Salmonella Typhimurium* are the two most common types and account for the majority of all human infections (US Department of Agriculture, 2009).

Salmonella bacteria may enter the bird via several routes (*Figure 2*). This has further complications regarding complete control of the bacteria. All these routes, however, do have one thing in common - Salmonella enters the bird via the beak. The crop is the organ where infection may easily develop and spread through the intestinal tract. Once infected, animals may develop into seeder birds that excrete high numbers of Salmonella via the faeces, thereby infecting other birds. In a control programme it is important to avoid this cycle of infection and re-infection. It is therefore necessary to pay attention to all the main routes, and to focus on feed and water, good hygiene, biosecurity and management practices.

Organic acids useful

Organic acids have shown to successfully help in the fight against controlling Salmonella. After the ban on antibiotics in the EU, organic acids became popular and were used as one of the main replacements, also for the control of Salmonella. Short chain fatty acids are said to be particularly effective in killing gram negative bacteria such as Salmonella. Organic acids may be used for controlling Salmonella via the feed as well as via the drinking water. It has become a common practice to blend organic acids for maximum control. Each organic acid has its own physical and chemical characteristics, leading to a specific anti-microbial activity. By combining acids in blends, the product develops a broad spectrum of anti-Salmonella activity leading to more effective control at a lower dosage (*Table 1*). Each serotype of the Salmonella family also has its own characteristics, which make it more or less sensitive to the effect organic acids. *Figure 3* shows that a blend of organic acids can effectively control the main Salmonella families, with the difference that *S. Enteritis* is less sensitive compared to *S. Thyphimurium*. Organic acids may be partially buffered, thereby forming salts in the product. This supports acids in working effectively, not only in the drinking water and feed, but also throughout the gastro-intestinal tract since part of the acids become available in the latter part of the small intestine. In fact, buffered acid products are combi-products used for controlling Salmonella both in drinking water as well as inside the bird.

The use of organic acids in the drinking water has additional advantages. Firstly, the flexibility in dosing means that it is easy to adjust the dosage when needed. Secondly, organic acids via the drinking water easily mix with all ingredients in feed, stomach and intestines. With a regular intake of water throughout the day, organic acids may also support the bird's system in fighting Salmonella that may enter the bird via other routes (*Figure 2*).

Broiler and layer trials

The effect of organic acids via drinking water on Salmonella prevalence was tested in several experiments, with broilers as well as laying hens. All products used were blends of short chain fatty acids buffered

Figure 1 - Salmonella prevalence for broilers and laying hen flocks in EU Member States (Source: EFSA, 2006 and 2007)

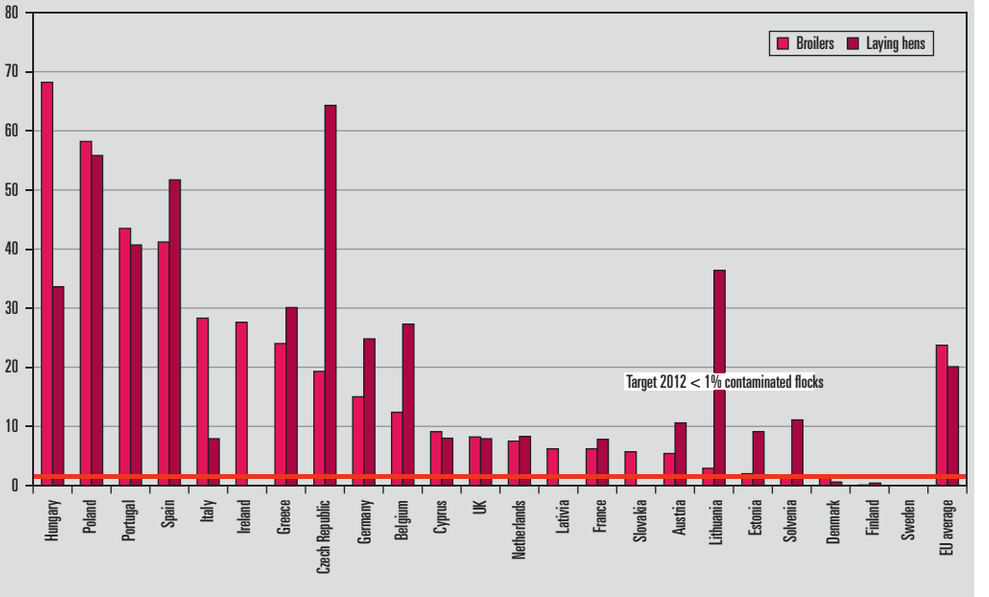


Figure 2 - Overview of the several routes of Salmonella infections

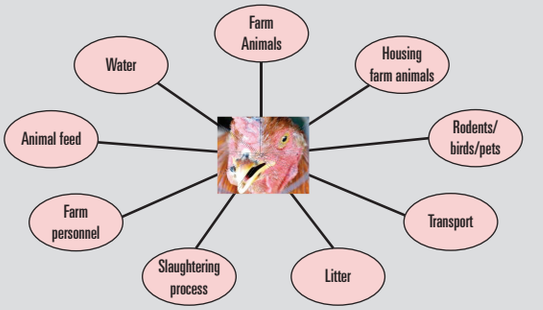
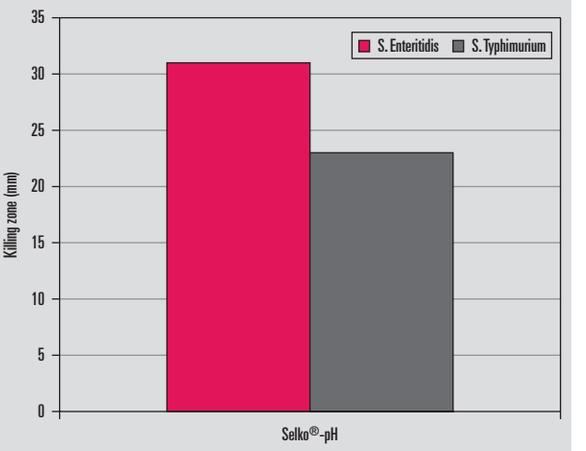
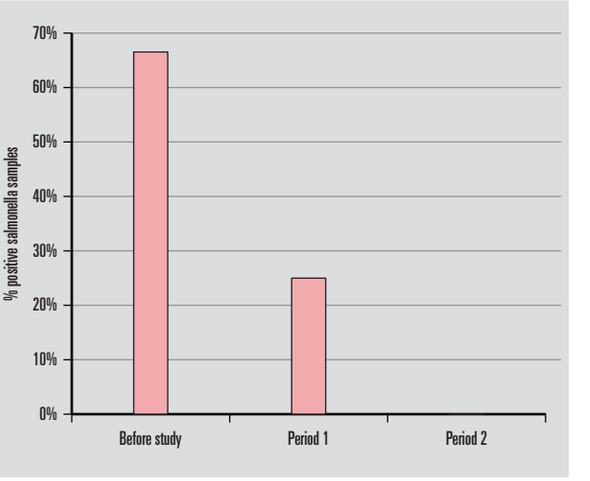


Figure 3 - Blend of organic acids (Selko®-pH) can effectively control the main Salmonella families (killing zone is a measure for Salmonella killing strength of organic acids). Source: Selko Laboratory, 2008



Testing for Salmonella in the laboratory. For monitoring the salmonella status, laying hen farmers have to analyse their flocks (swabs or overshoes) every 15 weeks from 22 weeks of age.

Figure 4 - Application of organic acids and reduced Salmonella prevalence in litter samples of laying hens in four German poultry farm houses (80,000 hens of different ages). During Period 1 (58 days) and Period 2 (35 days) a blend of organic acids (Selko®) was provided via the drinking water (2009).



with ammonium hydroxide, starting the Salmonella control in the drinking water and continuing via the crop into the intestinal tract. *Figure 4* shows the results of trials with laying hens with serious Salmonella problems over the whole farm. Sampling revealed that not only manure samples were Salmonella-positive, but also dust samples (cages) and samples taken in the feeding system. In such a farm, birds are constantly at risk to become infected, or re-infected with the bacteria. A laying hen operation has limited possibilities to reduce these routes of Salmonella as treating with antibiotics is not allowed, and cleaning and disinfecting is not enough to make the flock Salmonella-free. This emphasises the importance of Salmonella prevention.

In the trial, manure samples were taken right at the beginning before the trial began, and at the end of both test periods. Results show that the number of positive Salmonella samples decreased with the use or organic acids during a running laying hen operation, cutting short a main cycle of infection and re-infection. *Figure 5* shows the test results of broiler farms that had chronic Salmonella problems. An integrated approach was applied as application of organic acids via the drinking water (Selko®-pH) was combined with management measures (HACCP). These broiler farms were followed over cycles, showing a clear decrease in the number of farms that tested positive for Salmonella. Organic acids via the drinking water may also be used for an end-of-pipe solution at Salmonella-positive broiler farms. By applying organic acids in the last period before slaughter, Salmonella presence in the crop may be tackled adequately. This will reduce the spreading of Salmonella in the slaughterhouse and consequently the number of contaminated carcasses (due to cross-contamination.

Figure 5 - Application of organic acids (Selko®-pH) in combination with management measures reduced the number of Salmonella-positive farms in broilers (11 broiler farms of 1 million broilers, 2003). Two farms stopped the trial before the four rounds ended.

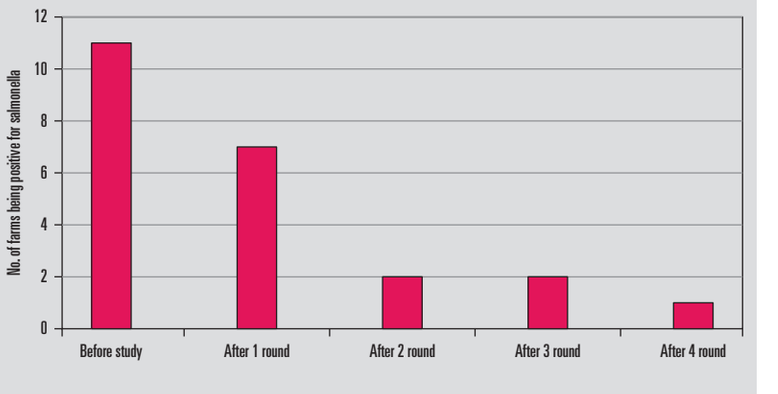


Table 1 - Blend of organic acids (Selko®-pH) control Salmonella more effectively than single acids. The effect on the minimum inhibitory concentration (MIC) values needed to control Salmonella bacteria in water.

Test Product	MIC Salmonella control
Blend most potent organic acids (Selko®-pH)	0.125%
Single acids:	
- Formic acid	0.25%
- Propionic acid	0.50%
- Acetic acid	1.0%

Source: Selko Laboratory, 2004

Conclusion

These studies show that organic acids via the drinking water offers a strong contribution to reduce and maintain low levels of Salmonella at broiler and layer farms. Due to its flexibility in dosing, application is relevant for prevention of Salmonella as well as reducing Salmonella prevalence in a running (laying hen) operation.

** References are available at request*