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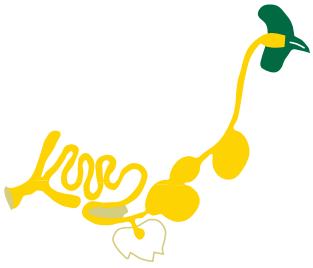
Science & Solutions

Zero *Salmonella* in 2014?

How organic acids can help you achieve your goal

Photo: Sebastian Kaulitzki



Gut integrity for performance

Learn all about the important functions of the gut barrier complex in poultry

Mycotoxins and poultry feed

Which mycotoxins are the main culprits of reduced poultry performance?

Editorial

Feed safety first

Salmonella and mycotoxins are among the most common hazards in animal nutrition and tackling the dangers they pose is an ongoing effort. To date, science has discovered up to 400 mycotoxins in contaminated animal feedstuffs. Although their concentrations rarely exceed legal limits, the real concern lies in their co-occurrences and synergistic effects that harm the immune system and impair gut integrity, leading to growth retardation and performance losses.

Since the BIOMIN Mycotoxin Survey Program began in 2004, 24,000 samples have been analysed to provide our stakeholders and customers with information on the mycotoxin risk potential in different regions worldwide. Although mycotoxins are detected in about 80% of animal feeds, transmission to humans via animal products is rare, except in a few cases of aflatoxins carried over in milk.

In contrast, *Salmonella* in feed materials pose an even greater risk to humans than animals. Although some *Salmonella* strains directly impair poultry health, their main danger lies in the threat to human health through their transmission via poultry meat or eggs. In the EU, around 100,000 cases of this zoonotic disease are reported every year, and over 40,000 are reported in the US, although the actual number of infections may be at least thirty times greater.

At the gut level, *Salmonella* and mycotoxins interact – the latter impacts gut integrity and opens the gate to the invasion of pathogens, like *Salmonella*. From a research perspective, it is therefore very important to combine different strategies to manage these risks, such as conducting surveillance programmes on mycotoxins, developing new strategies for counteracting mycotoxins and *Salmonella*, and finding approaches to improve gut barrier function and gut health in animals.

Gerd Schatzmayr PhD
Research Director

Even as safety standards in global food supply are improving, *Salmonella* infections continue to inflict huge losses in terms of productivity on farms, recalls from supermarkets and medical costs for patients. Minimising *Salmonella* should thus be a priority at every poultry farm.

Is zero *Salmonella*

Bacteria of the genus *Salmonella* are Gram-negative, facultative anaerobic bacteria belonging to the family *Enterobacteriaceae*. In poultry, two serotypes, *Salmonella* Gallinarum and *Salmonella* Pullorum, are known to produce clinical diseases such as fowl typhoid and pullorum disease. These two strains are the main cause of high mortality rates in poultry flocks that lead to substantial losses for farm owners. The export of contaminated breeding flock is suspended until the flock becomes free of *Salmonella* while the eradication of *Salmonella* is costly and may even lead to the closure of poultry units.

Many other serotypes such as *Salmonella* Typhimurium and *Salmonella* Enteritidis may infect internal organs, followed by contamination of poultry products such as meat and eggs. Food poisoning with *Salmonella* infected products becomes a true hazard to human health.

Poultry are usually infected through contaminated feed, infected breeder flocks, lack of effective biosecurity on farms, inadequate hygiene control during harvesting, transporting of broiler chickens and cross-contamination of carcasses during slaughter and processing. Different stress factors can reduce the efficacy of immune systems, creating favourable conditions for the bacteria to work further damage.

It is very hard to keep *Salmonella* under control because it is a faecal-oral infection and birds can excrete bacteria via their faeces for several months without showing any symptoms of the disease. *Salmonella* strains are capable of surviving for six or more years in the environment and biosecurity is therefore a major factor towards reducing the risk of *Salmonella* in poultry farms.

Photo: khemporn tongphay

Renata Breitsma
Director of Competence Center, Acids

possible?

Organic acids and their antimicrobial efficacy

The addition of organic acids has been shown to contribute to environmental and feed hygiene as well as a healthier gastrointestinal tract (GIT). In their non-dissociated form, organic acids can penetrate the bacterial cell wall and disrupt the metabolic processes of bacteria by altering their internal pH. This forces bacterial cells to expend considerable resources in bringing their internal pH back to a normal, metabolically optimal level.

The effort made to rebalance internal cellular pH is an energy-draining process which can eventually stop the growth of the bacteria or even kill it. The anion part of the acid is trapped inside the bacteria because it does not diffuse freely through the cell wall. The accumulation of anions becomes toxic for the bacteria, interrupting enzymes and DNA synthesis.

Combining different organic acids and using acid blends instead of singular organic acids has become increasingly common over the last few decades. This is because using combinations of organic acids instead of single acids broadens their spectrum of activity. It has been shown that the antimicrobial effect of a blend of formic and propionic acids against *Salmonella* and *E. coli* (Biotronic® SE /forte) increased by up to 24% compared to the efficacy of individual acids.

In addition, there is a growing body of evidence that some essential oils or their phytochemical constituents as well as permeabilizing substances can act synergistically with organic acids. The permeabilizers generally do not have a bactericidal effect but are able to weaken the outer membrane of Gram-negative bacteria and facilitate the action of other antimicrobials against the bacteria.

However, different permeabilizers act differently with various antimicrobial substances. When combining antimicrobial substances and permeabilizers, it is of great importance that they interact in a manner that increases the permeability of a pathogen's cell membrane. Such a synergistic effect has been confirmed in Biotronic® Top3, a product where the inclusion of a permeabilizing substance, Biomin® Per4izer®, increased the antimicrobial effect of a blend of organic acids and the phytochemical, cinnamaldehyde.

Raw materials and compound feed

Contaminated feed is a known source of *Salmonella* infections and a potential route of disease transmission to animal and human populations. Heat treatment, usually during conditioning, pelleting or extrusion has been shown to be an effective way of reducing microbial loads in feed; however, absolute "feed sterility" cannot be achieved.

Moreover, these methods do not prevent feed recontamination, which is a true hazard in the feed production chain, especially in the finished product sector, cooling area for pellets, bulk transport to the farm and storage of the feed in the farm silos.

A multitude of steps must be taken to secure the hygienic status of feed. These steps include thermal treatment and the addition of compounds to control microorganisms in feed. Constant treatment with organic acids has a residual protective effect in feed. It helps to reduce the risk of feed recontamination and minimise the contamination of milling and feeding equipment.

The antibacterial efficacy of Biotronic® products in artificially contaminated feed was evaluated in a crop assay. The feed was contaminated with a high level of *Salmonella* Enteritidis and diluted with physiological saline solution. The cell count of *Salmonella* was determined after the contamination at 0, 1 and 2.5 hours of incubation under optimal conditions. Results showed that *Salmonella* replication grew steadily under optimal conditions while *Salmonella* counts declined in the group containing the acidifier (*Figure 1*).

The use of organic acids and their mixtures is viewed with caution by many feed mills. The corrosive nature of organic acids can lead to machinery damage, particular when a high proportion of the feeds are treated. The

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Table 1. Quantitative *S.* Eteritidis detection 5 and 10 days post-infection in the cecum

Groups	Cecal samples log cfu *Salmonella*/g digesta	
	5 days post infection*	10 days post infection
Control	2.25[a]	2.63[a]
Biotronic® Top3 1 kg/t of feed	0.87[b]	1.29[b]

*Infection level: 10^5 colony forming units (cfu) *S.* Enteritidis;
[a,b] significant difference $P<0.05$.

Source: BIOMIN trials, 2013

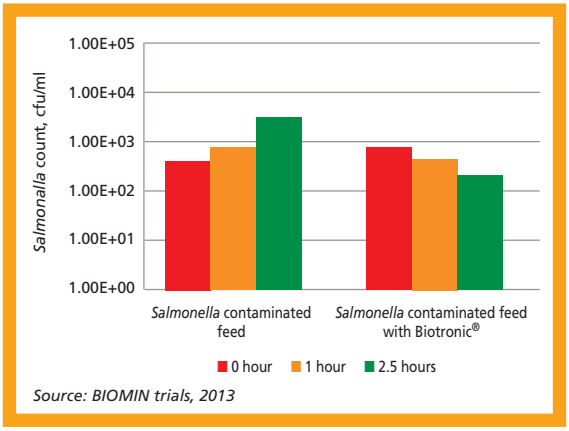
Biotronic® product line consists of buffered organic acids with the suppressed ability to corrode metal surfaces and is therefore suitable for use in feed mills.

Controlling *Salmonella*

Some *Salmonella* serovars, e.g. *Salmonella* Enteritidis harbour innate properties to infect the poultry reproductive tract. The passage of an egg through the contaminated cloaca or in a *Salmonella* infected environment can cause outer egg shell contamination. Internal egg contamination is caused by shell penetration through cracks or by colonization of the reproductive tract and thus bacteria enters the forming egg.

In most European countries today, the implementation of *Salmonella* monitoring programmes has reduced the number of cases of human salmonellosis due to the consumption of contaminated eggs. Unfortunately, *Salmonella* infection has not been completely eliminated yet and the costs of hospitalisation and treatment can amount to €4,000 per patient.

Figure 1. Effect of acidification on *Salmonella* reduction in artificially contaminated feed.



The efficacy of Biotronic® on the reduction of *S.* Enteritidis in the GIT was evaluated in artificially inoculated SPF broilers. The control birds received a standard broiler diet, whereas the trial group had an additional supplementation of Biotronic® Top3 1 kg/t of feed. The results showed that counts of *S.* Enteritidis in the Biotronic® Top3 group were reduced by 1.4 and 1.3 log cfu/g digesta at five and 10 days post infection, respectively (*Table 1*). Converting the log reduction in percentage, it was shown that the trial group had a 90% lower *Salmonella* count in the cecum compared to the control group.

Prevention

Salmonella control is key to preventing the introduction of *Salmonella* in the farm. A significant number of pathogens are transported by feed and it is almost impossible for animals to consume zero *Salmonella* feed.

It is therefore important to use current technology and know-how to improve feed hygiene by reducing bacterial counts to a safe level for animals, preventing feed from recontamination and adopting proper farm management. Using acidifiers in feed and water minimises *Salmonella* infection and promotes gut health, thereby enhancing poultry performance. The use of acidifiers can be seen as a management tool that effectively controls *Salmonella*, the main culprit of poultry disease.