A strategic approach to salmonella control in poultry

by Christian Lückstädt, technical director, Addcon, Asia.

Both the feed industry and the food production sector still suffer from losses due to the contamination of feed with pathogenic bacteria and their resultant impacts in the animal, such as lower weight gains and increased mortality.

Banning the use of in-feed antibiotics (AGPs) in livestock, as happened in the EU as well as in parts of Asia, led by South Korea, puts more pressure on animal producers and feed millers. It also poses an important challenge to innovative animal nutritionists.

Addressing these problems in a suitable manner can help the industry regain the trust of consumers and NGOs, concerned about the safety of food. Now, alternative feed ingredients are being adopted in order to fill the gap left by removing AGPs from the food chain.

Organic acids

Organic acids have long been used to counteract Gram negative pathogenic bacteria in animal feed, mainly in pig production. This approach is currently being further investigated for poultry nutrition – especially to combat salmonella.

Contamination with pathogenic bacteria like salmonella creates an enormous social and economic burden worldwide.

The annual cost of salmonella to the UK economy for instance exceeds US$76 million; and is estimated to be around US$4.1 billion across the EU. Human cases of salmonellosis have been widely reported. The latest figures from the EU (2007) mention that 152,000 people were directly affected by salmonella in that year. Combating salmonella is therefore a matter of some urgency, with management and dietary strategies a crucial strategy in poultry production.

Table 1. Results of various Formi NDF dosages on campylobacter inhibition (% positive samples).

	Control	Formi NDF 0.3%	Formi NDF 0.6%
Crop (microbiol)	60	0	0
Intestine (microbiol)	80	20	0
Meat (serol)	80	0	0

Table 2. Results of various Formi NDF dosages on salmonella inhibition (% positive samples).

	Control	Formi NDF 0.3%	Formi NDF 0.6%
Crop (microbiol)	20	0	0
Intestine (microbiol)	20	0	0
Faeces (microbiol)	25	0	0
Meat (serol)	0	0	0

The potential of single organic acids in feed preservation lies in their ability to protect feed from microbial and fungal destruction. Their effects on stomach pH and gut flora have also been known for decades and proven in many laboratory and field trials.

Acidifiers act as performance promoters by lowering the pH in the gut (mainly upper intestinal tract), inhibiting the proliferation of unfavourable micro-organisms. Gut acidification stimulates enzyme activity and thus optimises digestion and the absorption of nutrients and minerals.

Un-dissociated forms of organic acids penetrate the lipid membrane of bacterial cells and dissociate into anions and protons. After entering the neutral pH of the cell's cytoplasm, organic acids inhibit bacterial growth by interrupting oxidative phosphorylation and inhibiting adenosine triphosphate-inorganic phosphate interactions.

Formic acid

One of the first reports of improved broiler performance when diets were supplemented with single acids was for formic acid. Later, Izat et al. (1990a) found significantly reduced levels of Salmonella spp. in carcase and caecal samples, after including calcium formate in broiler diets.

Izat et al. (1990b) went on to show that buffered propionic acid could be used to counteract pathogenic microflora in the intestine of broiler chickens, and resulted in a significant reduction in E. coli and Salmonella spp, also on the carcase.

The use of pure formic acid in breeder diets reduced the contamination of tray liners and hatchery waste with S. enteritidis drastically.

Hinton and Linton (1988) examined how salmonella infections could be controlled in broiler chickens using a mixture of formic and propionic acid. They demonstrated that under experimental conditions, 6kg/t (0.6%) of this organic acid blend was effective in preventing intestinal colonisation with Salmonella spp. from naturally or artificially contaminated feed.

Improving performance

Improving broiler performance or hygienic conditions with the aid of organic acids has been reported by many sources, as mentioned above. An important limitation, however, is that organic acids are rapidly metabolised in the fore-gut (crop to gizzard) of birds, which will reduce their impact on growth performance. Addcon's patented poultry product, Formi NDF, the latest member of the Formi product group, has been proven to be effective against pathogenic bacteria along the whole gastrointestinal tract, including salmonella and campylobacter.

As stated above, Formi NDF counteracts serious pathogenic bacteria in poultry production. In order to further prove this effect a trial was carried out.

The objective of this trial was to evaluate the effect of Formi NDF (0.3% and 0.6%) in starter and grower diets for broilers. The product's ability to control bacterial conta-

Continued on page 17

Table 3. Results of microbiological investigation of the intestine (CFU/g).

	Control	Formi NDF 0.6%
Enterobacteria	10^7	10^5
Lactobacilli	10^7	10^8
Bifidobacteria	10^5	10^6

Continued from page 15
mination in the digestive tract was tested against a negative control under hot conditions in Spain.

Some 1750 one-day old broilers distributed between 14 batches of 125 animals each (five batches per treatment; excluding control with four batches only) were used. The broilers were fed a starter diet for 21 days; a grower diet for 18 days and a finisher diet for three days.

After 39 days of treatment, prior to the supply of finisher feed, 10 birds from each of the three treatments were taken for further microbial analysis.

Formi NDF was only given in the starter and grower diets. The finisher feed (last three days) did not contain Formi NDF and was the same in all 14 lots. The results achieved are shown in Tables 1-3.

Beneficial effects

These results clearly show the beneficial effects of Formi NDF against pathogenic bacteria in broilers. No positive samples of salmonella and campylobacter were found in meat from broilers fed Formi NDF.

Furthermore, there were no positive samples for salmonella and campylobacter in the crop of Formi NDF fed groups and no positive samples for salmonella. Significantly reduced campylobacter counts were found in the intestines of Formi NDF fed birds. Notably lower enterobacter numbers and distinctly higher lactobacilli and bifidobacteria numbers show the beneficial impact of Formi NDF on the intestinal microbiota.

	Control	Formi NDF 0.5%
Number of birds	17,250	17,250
Final weight (g)	2130	2190
FCR	1.95	1.91
Mortality (%)	1.94	1.49

Table 4. Broiler results from commercial trial in France.

The reduced impact of pathogenic bacteria on the broiler, as well as the improved gut microflora, leading to a state of eubiosis in treated chickens, suggests that including Formi NDF will also result in improved bird performance. This hypothesis formed the impetus for a further broiler trial.

A commercial trial with Formi NDF (0.5%) was conducted in France. Some 34,500 day old birds were randomly selected and divided into two trial groups. Performance data were recorded at the end of the trial on day 42.

As can be seen from Table 4, overall performance in the group with Formi NDF was increased. The addition of 0.5% Formi NDF resulted in an increase of 2.8% in weight gain, while the feed conversion rate was improved by 2.1%.

Furthermore, the mortality was reduced by more than 23%.

An economic analysis based on the European Broiler Index (EBI) showed that use of the product gives a clear benefit to the farmer. EBI is widely used to describe the efficiency of broiler production and its calculation is shown in Table 5.

EBI = Daily weight gain (g) x survival (%)/10 x FCR.

Table 5. Calculation for the European Broiler Index (EBI).

Formi NDF inclusion improved the EBI by almost 5.5% (from 250.4 to 264.1), thus securing an optimised broiler production.

The mode of action of the acidifier in poultry is mainly due to its antimicrobial action, unlike in pigs where a key activity is the reduction of stomach pH. In the trials discussed above, the final body weight of the broiler chickens fed acidified diets was increased. Average daily weight gain was higher in the acidifier group, and FCR was reduced, resulting in an improved European Broiler Index.

Additionally, other trials have shown improved health status in chickens, as demonstrated by a significantly improved gut microflora – reflected in lower enterobacter numbers and high lactobacilli and bifidobacteria counts.

Using acidification in broiler diets is a valuable strategy in the producer's armoury against productivity losses caused by pathogenic bacteria.

Combined strategies, including coarse feed particle size along with the use of organic acid salts like Formi NDF can have a further beneficial impact in the fight against salmonella.

A recent study demonstrated the potential of potassium diformate (Formi), in combination with coarse grinding of the feed, to inhibit the growth of salmonella in pigs. With this combination it was possible to lower the excretion of salmonella remarkably during the fattening period.

Furthermore, the use of Formi during the grower phase, with the same feed texture, led to a significantly lower salmonella prevalence in the Lnn. Ileocaecales.

A healthy gut

The application of Formi to the diet resulted in statistically lower caecal pH-values as well as higher levels of propionate and butyrate in the caecum at slaughter.

Other studies have proven that the short chain fatty acids propionate and butyrate, stimulated by Formi inclusion in the diet, can inhibit the expression of invasive genes of salmonella.

Butyrate is known to stimulate intestinal epithelial cell function, including regulating gene expression. Higher butyrate concentrations in the distal part of the digestive tract, especially in the colon, also support the growth and development of epithelial cells in the gut, increasing villus length and crypt depth – factors that indicate a healthy gut.

Formi therefore contributes to an optimal gut microflora, even in the last part of the gastro-intestinal tract of the pig, by promoting butyrate production.

Studies on gut physiology and microbiology in poultry imply that such an approach will exert similar beneficial effects in poultry.

The published results described above prove irrefutably how a healthy gut with inhibited growth of pathogens and food safety can be achieved by dietary means.

Additionally, a balanced acidifier, such as Formi NDF, increases the performance of broiler chickens and is a sustainable option for maintaining or improving broiler growth and efficiency, without resorting to supplementation with an AGP. ■

References available from the author on request

christian.lueckstaedt@addcon.net