

Organic acids are healthy feed supplements

The antibiotic ban in the EU, and the continuing increase in the demand for drug-free poultry worldwide, caused poultry companies to re-consider organic acid feed supplements. They are finding that organic acids are providing benefits beyond growth and improved feed conversion, such as minimizing the risk of pathogen transfer and enhancing food safety.

By Novus International Inc.

Bacteria inhabit nearly all of the Earth's ecosystems. Some live in total darkness and under tremendous pressure deep on the ocean floor. Others thrive at cold temperatures. A number of bacteria species inhabit the digestive tracts of poultry and other animals. However, no single bacteria species can live in every type of ecosystem.

Acid tolerance is a major factor that limits how well certain types of bacteria survive in an ecosystem. Most bacteria do not grow in acidic (low pH) environments. Because of the bactericidal properties of acids, humans have used acidification for years to purify and preserve food. Acetic acid for example is an organic acid that is an essential part of pickling brine that effectively inhibits bacterial decomposition (spoilage) of fruits, vegetables and meats.

Inhibition of organic acids

Organic acids inhibit the growth of pathogenic bacteria through several proposed mechanisms. One of the most accepted mechanisms involves the disruption of cell membrane-transport functions that allow bacteria to maintain a relatively stable state of equilibrium with their environment by absorbing nutrients and excreting waste. Upon entering the interior of a pathogenic bacteria cell (the cytoplasm), the organic acids lose protons (a hydrogen ion) due to the higher pH of the cytoplasm. As more organic acid is absorbed, the free hydrogen ion content of the cytoplasm increases, resulting in a lower pH of the cytoplasm. For the pathogenic bacteria to survive, the bacteria must remove the hydrogen ion from the



Organic acid supplementation has a positive effect on the growth and feed conversion of broilers.

cytoplasm in order to maintain a neutral pH inside of the cell. The removal of the hydrogen ion is accomplished through active transport, a biological mechanism that utilizes and eventually depletes the energy reserves of bacteria. This not only limits the bacteria's ability to reproduce or synthesize toxins, but eventually results in the death of pathogenic bacteria such as *Escherichia coli*, *Salmonella* spp., *Listeria*, and *Campylobacter*, all of which are linked to food-borne human illness. In addition to reducing the growth of pathogenic bacteria, organic acids facilitate the growth of *Lactobacillus* and *Bifidobacteria* throughout the digestive tract of poultry and other animals. These bacteria improve gut health by producing lactic, acetic, propionic and butyric acid, organic acids that further limit the growth and colonization of pathogenic bacteria throughout the digestive tract.

Good replacements

In the past, poultry feed manufacturers have used organic acids, but only in a limited capacity. Reluctance for their widespread use is largely due to a limited amount of experimental data, a lack of understanding behind their mode of action, and other misconceptions. However, many poultry companies are reconsidering this simple technology as a means of

improving animal health and food safety.

Many poultry nutritionists in Europe and other world areas that are not using antibiotics agree that organic acids can replace growth-promoting antibiotics in poultry feed. In addition to enhancing and maintaining performance, organic acids have been shown to improve meat quality, reduce the impact of poultry production on the environment, and enhance the welfare of poultry.

Combinations of organic acids are more effective than supplements that contain only one type of organic acid. This is because different types of organic acids diffuse through the bacterial cell wall and membrane and into the cell cytoplasm at different rates. These acids dissociate to form a conjugate base and a free hydrogen ion at different rates and respective pKa values.

Beyond growth and feed conversion

Dr. Greg Mathis of the Southern Poultry Research, Inc., Athens, Georgia, and Dr. Chuck Hofacre of the University of Georgia completed in November 2005 a study in which they supplemented the drinking water of male broiler chicks with a specific combination of lactic, phosphoric and HMTBa—Alimet® feed supplement (ACTIVATE® WD US MAX,

Table 1 - Effects of supplementation of the drinking water with organic acids (ACTIVATE®) on the performance and Salmonella infection of broiler chicks.

Supplementation level	Body weight gain at 49 days (kg)	Feed gain	Salmonella-positive		
			Tagged	Untagged	Drag (%)
0%	3.007	1.947	1.8	2.2	67
0.04%	3.013	1.900	1.3	0.7	17
0.08%	3.029	1.910	1.8	0.7	33

Table 3. Impact of organic-acid supplementation of the drinking water and feed on the performance and Salmonella infection of male broiler chicks.

	Body weight gain at 49 days (kg)	Feed gain	Salmonella-positive		
			Tagged	Untagged	Drag (%)
Treatment 1	3.186	1.852	0.8	0.8 ^a	50
Treatment 2	3.187	1.843	0.2	0.3 ^{ab}	0
Treatment 3	3.162	1.845	0.2	0.0 ^a	0
Treatment 4	3.194	1.839	0.2	0.5 ^{ab}	0

^{ab} Averages with different superscripts are statistically different.

from Novus International Inc.) at 0%, 0.04%, and 0.08%.

The treatments were provided to the broiler chicks from 1 to 14 days of age and 42 to 49 days of age. On the first day of the study (Day 0), the researchers orally infected 30 chicks from each pen of 60 chicks with *Salmonella heidelberg*. The infected chicks were identified with tags for future analysis and were referred to as “tagged”, while non-infected chicks were referred to as “untagged.” In addition to body weight and feed consumption data, ceecal tissues and drag-swabs of the litter were collected from each pen for *Salmonella* testing at the end of the study.

At 49 days of age, the organic acid supplements did not statistically affect growth or feed conversion (feed:gain) compared to that of the unsupplemented control (Table 1). However, weight gain and feed conversion were numerically higher for broiler chicks that consumed the organic acid-supplemented water. “*Salmonella* does not normally reduce performance so we were not surprised with the results,” the researchers explained. “The plus is that ACTIVATE® did not suppress water consumption and therefore growth and feed to gain.”

Reduction in contaminants

Although the organic acid supplementation did not statistically affect performance, Mathis and Hofacre did observe 50% and 37.5% fewer total *Salmonella*-positives in the broiler chicks receiving the 0.04% and 0.08% ACTIVATE® organic acid supplements, respectively (Table 1). Reduction in the incidence of horizontal transmission of *Salmonella* infection in live birds has positive implications on food safety and product quality, including shelf-life of fresh poultry.

Another observation was that the incidence of *Salmonella*-positive tests was markedly reduced in those chicks that

were not infected at the beginning of the study. Based on this, it appears organic acid supplementation of the drinking water impedes the transfer of *Salmonella* from infected broilers to uninfected broilers.

In addition, drag swabs of the pens showed that 67% of the pens that housed the unsupplemented broilers still had a detectable level of *Salmonella* (Table 1). For those pens that were given the specific combination of organic acids the amount of *Salmonella*-positive drag swabs was 17-33%. According to these data, organic acid supplementation of the drinking water may reduce the spread of *Salmonella* infection between flocks in a built-up litter program.

Double proof

Mathis and Hofacre conducted in March 2006, a follow up study that involved four treatments (Table 2). Treatment 1 served as the unsupplemented control. In Treatment 2, the male broiler chicks were supplemented with a combination of formic, propionic and HMTBa—ALIMET® feed supplement (ACTIVATE® WD MAX) through the drinking water at 0-14 and 42-49 days of age. Treatment 3 was similar to Treatment 2, except Treatment 3 was supplemented with Tributyrin (Baby C-4 from Silo, Italy) and fed from 0-49 days of age. Treatment 4 was also similar to Treatment 2; however, it was also supplemented with Tributyrin and fed from 0-14 and then 42-49 days of age.

The researchers orally infected 30 chicks from each pen with *S. heidelberg* at one-day of age. The infected chicks were tagged for future identification. At the end of the study, ceecal and crop samples from the birds and drag-swab samples from the litter were collected from each of the pens for *Salmonella* analysis.

As in the earlier study, the organic acid supplements did not statistically affect

Table 2 - Treatment descriptions.

	ACTIVATE® WD*	Tributyrin**
Treatment 1	None	None
Treatment 2	0.04%	None
Treatment 3	0.04%	0.2%
Treatment 4	0.04%	0.2%

*ACTIVATE® WD is an organic acid drinking water supplement from Novus International, Inc.

**Tributyrin (Baby C-4) is an organic acid feed supplement from Silo, S.r.l., Italy.

broiler chick performance (Table 3). However, broilers that received the organic acid supplementation through the water and through the feed at 0-14 and 42-49 days of age numerically gained the most weight and had the greatest feed efficiency.

Mathis and Hofacre found a significantly lower number of total *Salmonella*-positive crop samples in the broilers that consumed organic acids via the drinking water and/or the feed. The lower number of *Salmonella*-positive, non-tagged birds confirmed the hypothesis that organic acid supplementation reduces *Salmonella* shedding in broilers. This led to the conclusion that “ACTIVATE® WD alone or in combination with Tributyrin reduced the spread of *Salmonella* in naïve birds when infected birds were part of the population.”

Drag swabs showed that 50% of the litter in the pens that contained unsupplemented broilers had a detectable level of *Salmonella*. For all treated pens the amount of positive drag swabs was 0%. The researchers concluded that “...the lack of any presence of *Salmonella* in the litter of the treated pens was due to treatment effect and not due to salmonella dying off during the course of the study.”

Effects on performance

In both studies, organic acid supplementation numerically improved the growth and feed conversion of male broiler chicks. However, these improvements were not statistically significant. The overall performance of the broilers was high and therefore it would have been unlikely that organic acids or even sub-therapeutic levels of antibiotics would have significantly improved performance.

More importantly, the studies demonstrated the possibility that organic acid supplementation inhibited the shedding of *Salmonella* infection, reducing bird-to-bird transmission and lowering the *Salmonella* load in the environment. The positive impact of organic acid supplementation on *Salmonella* shedding and possible horizontal transmission has powerful implications in food safety. *Salmonella* is a major cause of food-borne illnesses. It is likely that organic acid supplementation will have similar beneficial effects on other bacteria, such as *E. coli*, *Listeria*, and *Campylobacter*. ■