The winning formula for poultry performance

by Marc Kinjet, Perstorp Performance Additives, PO Box 10, Waspik, 5165, The Netherlands.

Mainly due to the concern of the spread of multi-resistant bacteria, the use of antibiotic growth promoters in animal feed has been forbidden in the European Union since the beginning of 2006.

For more than a decade researchers have been looking for alternatives to replace antimicrobial growth promoters (AGP) in both feed and water. It is well established that organic acids and blends of organic acids show antibacterial activities and that they enhance the digestibility of various feed ingredients.

Antibacterial effect

The antibacterial effect of organic acids is based on the principle that undissociated acid molecules are transported passively through the bacterial cell wall. Once inside the cell the organic acid molecule dissociate into the H^+ proton and the A^- anion.

Nowadays, more evidence is accumulated, showing that the effect of organic acid on bacterial cell metabolism is not only due to a depletion of energy as a result of the proton shuttling out of the cell but also that organic acids, and especially lactic acid, may disrupt the lipopolysaccharide layer on the microbial membrane surface.

Growth inhibition is also enforced by the impact of the anion on various metabolic processes within the cell, including osmotic stress and the displacement of the glutamate anion from the cell, whereby amino acid metabolism is disturbed.

The inhibition of bacterial cell metabolism is most likely organic acid specific, as chain length, side chain composition, pKa values and hydrophobicity play a key role.

These phenomena give an explanation for the fact that specific blends, such as a combination of formic and lactic acid, are more effective than single acids in inhibiting bacterial cell growth and enhancing animal performance.

Enhancement at pH6

As seen in previous research some organic acids have the ability to disrupt the outer membrane of bacterial cells. However, the greatest effect of short chain fatty acids is seen at lower pH levels and in many parts of the gastrointestinal tract the pH is in the range between 6 and 7.

It is known that pathogenic bacteria, such as salmonella are migrating to the distal parts of the gastrointestinal tract, with a preference in poultry for the caeca.

In order to control the number of pathogenic bacteria in the gastrointestinal tract and to alter the physical conditions in such a way that it favours the growth of lactic acid bacteria it is possible to combine organic acids and essential oil to make use of their synergistic effects.

In nature many natural compounds are known for their antibacterial properties, as they are the defence mechanisms of plants against predatation by bacteria, fungi and insects.

During the last decade many in-vitro studies found that there is a clear synergistic effect between organic acids and essential oils at pH levels close to neutral to inhibit the growth of harmful bacteria.

At first special attention was given to the inhibition of Gram negative enterobacteria such as salmonella and E. coli.

In Fig. 1, it is shown that at pH6 the combination of organic acids and essential oils inhibited the growth of the enterobacteriaceae with at least 4 $\log_{10}$. Further, it became clear that the combination of organic acids and essential oils also enforced the growth inhibition of Gram positive bacteria, such as clostridia.

Organic acids in poultry

The use of organic acids in poultry production was initially meant to inhibit the growth of harmful micro-organisms outside the intestinal tract. In recent years more focus has been placed on the control of harmful bacteria within the birds itself and on the improvement of zootechnical parameters by means of organic acids.

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Fig. 1. The effects of organic acids (formic and lactic) and essential oils on the growth of various Gram negative and Gram positive bacteria.

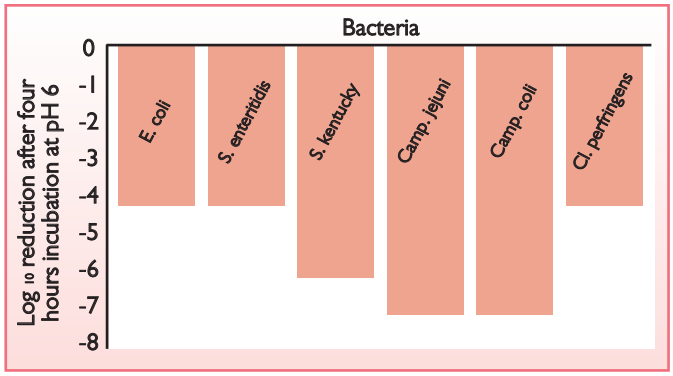
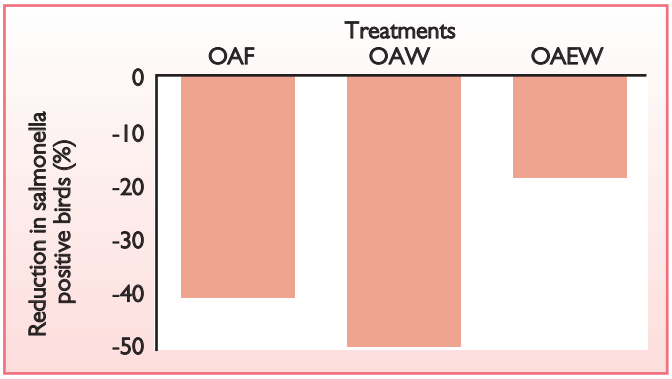


Fig. 2. The reduction (%) in the number of salmonella positive birds after seven days of treatment (CCL and Perstorp, 2008).



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To administer organic acids to poultry it can be incorporated in the feed or in the drinking water. Both feed and water may contain significant numbers of harmful bacteria and therefore it is necessary to treat the feed during the manufacturing process in the feed mill and the water on the farm.

Combinations of organic acids have shown to be able to decrease the salmonella numbers in artificially contaminated feed by 7$\log_{10}$.

Later it became clear that organic acids in the feed also have a very positive effect on the reduction of harmful bacteria in the crop and that they are able to reduce the number of salmonella on farm infections by means of organic acid treated feed.

Accordingly, the treatment of water with organic acids is well established especially to prevent re-contamination, with salmonella or clostridium, of the crop after feed withdrawal just before the birds are transported to the slaughterhouse.

To study the effect of a mixture of organic acids in combination with essential oils on Salmonella java challenged broilers, an experiment was set up in co-operation with CCL in the Netherlands.

We used 240 one day old female broiler chicks (Ross 308) from a salmonella free breeder flock. The birds were housed in groups of 10 in cages and they received a normal commercial broiler feed, whereby the starter feed was exchanged by the grower feed at day 17.

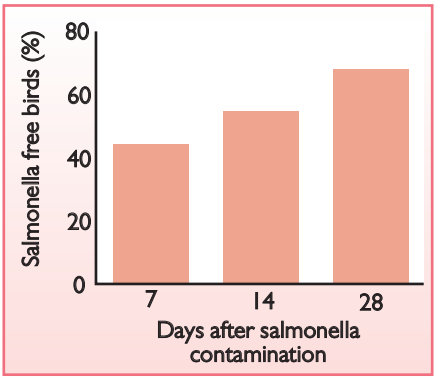

Fig. 3. The effect of a combination of organic acids and essential oils on the number of Salmonella java positive birds (CCL and Perstorp 2008).

At day five all chicks were challenged with Salmonella paratyphi B var. java (01P5016-CCL).

The birds were divided into four treatments, of which one was the control group, group 2 (OAF) received 0.3% of an organic acid mixture in the feed, whilst group 3 (OAW) received the organic acid via the drinking water (0.1 %). Finally group 4 (OAEOW) received the mixture of organic acids and essential oils via the drinking water (0.1%).

Cloacal swabs were taken from every bird for continuous weeks, starting at day eight followed by day 13, 20 and 27.

The results showed that the Salmonella java contamination after seven days was reduced with 38% for the organic acid mixture in feed, 47% for the organic acid mixture in drinking water and 15% for the treatment of drinking water with organic acids and essential oils (see Fig. 2).

However, only the group with the combination of organic acids and essential oils was able to reduce the number of Salmonella java positive birds over the whole period until slaughter (see Fig. 3).

Implications for poultry

As standards for food hygiene are continuously rising, feed hygiene needs to keep the same momentum. For making sure that birds are not re-contaminated after feed withdrawal it should be a standard procedure to treat them with organic acid enriched drinking water.

For strict hygiene measurements it is good to know that the growth of pathogenic bacteria, such as salmonella, E. coli and campylobacter in feed, water and birds can be contained by the use of organic acids in combination with essential oils. ■

References are available from the author on request