Satisfying the demands of the highly developed modern broiler

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Diets Feeding duration	Pre-starter Day 0 to 7	Starter Day 8 to 21	Grower Day 22 to 35	Finisher Day 36 to 42
Metabolisable energy (ME) in kcal/kg	2950	3000	3100	3150
Dry matter (%)	88.1	88.2	88.2	88.1
Crude protein (%)	22.0	20.8	19.4	18.0
Amino acids[*]				
Lysine (%)	1.33	1.15	1.07	1.02
Methionine (%)	0.68	0.54	0.51	0.49
Threonine (%)	0.87	0.75	0.70	0.66
Tryptophan (%)	0.21	0.22	0.20	0.18
Minerals				
Calcium (%)	0.94	0.88	0.82	0.76
Phosphorus (%)[**]	0.47	0.44	0.41	0.38

[*]Digestible levels [**]Available phosphorus

Table 1. Composition of the experimental diets.

Genetic development over the last half century has produced a broiler with an immense potential for both rapid growth and also highly efficient feed conversion. However, to satisfy the demands of this highly developed bird it is essential to ensure that its needs are met in every way; environmentally, nutritionally and in terms of intestinal health.

The intestine of a broiler chicken, and other animals, is a symbiotic mix of bacteria which have a beneficial effect to the host through competitive exclusion of pathogenic bacteria, or by producing beneficial products, such as vitamins.

Symbiotic balance

The symbiotic balance of the intestinal bacteria can be disturbed by varying stresses such as environmental conditions, nutritional changes and external bacterial challenges through contaminated foods.

For many years these challenges were suppressed using prophylactic antibiotics.

However, since the banning of these products in Europe and some other countries worldwide other strategies have had to be found to overcome the harmful effects of intestinal pathogenic bacteria.

The need to maintain eubiosis in the intestine is paramount to achieving genetic potential and economic performances; as any disruption will have negative effects, even with a slight dysbiosis, resulting in wet droppings or diarrhoea.

This will reduce the transit time of the digesta in the intestine resulting in decreased digestion and nutrient uptake. With more severe disruptions clinical diseases can develop which will damage the intestinal integrity requiring the host's immune system to react to overcome the intestinal crisis. This requires increased energy to function as well as the additional energy needed to repair damaged tissue in the intestine.

A balanced intestinal microflora is important to maintain; as is the prevention of any build up of potentially harmful bacteria. Since the banning of antibiotic growth promoters many alternative methods to maintain a balanced intestinal microflora have been researched.

Organic acids have been recognised as being able to reduce some bacterial pathogens as E. coli, salmonella and campylobacter for many years and are quite widely used as a way of reducing contaminations in feed, and also in the intestinal tract.

However, efficacy can be severely limited when the organic acids are in low concentrations.

For many years Europe has been a strong market for acidifiers, thanks initially to the drive to remove salmonella from poultry production.

However, feed contamination with coliforms and salmonella is seen widely throughout the world and in varying degrees.

This can be further exacerbated in the hot humid climate of the tropics, where not only bacteria thrive, but also moulds and fungi.

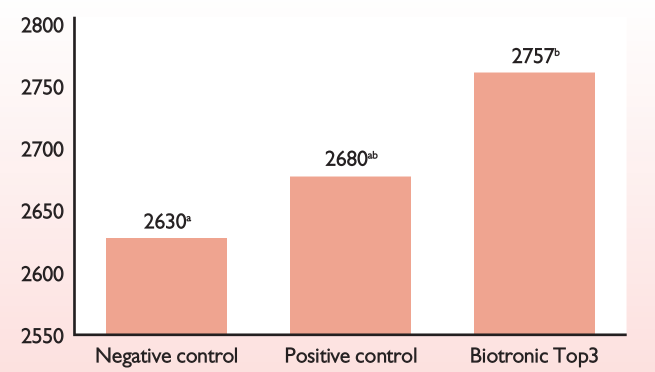
Acidifiers

Propionic acid is widely acknowledged as being not only very effective against fungi and bacteria, but has been used successfully in raw material preservation and feed acidification.

Formic acid was also widely used in combination with propionic acid in the development of salmonella

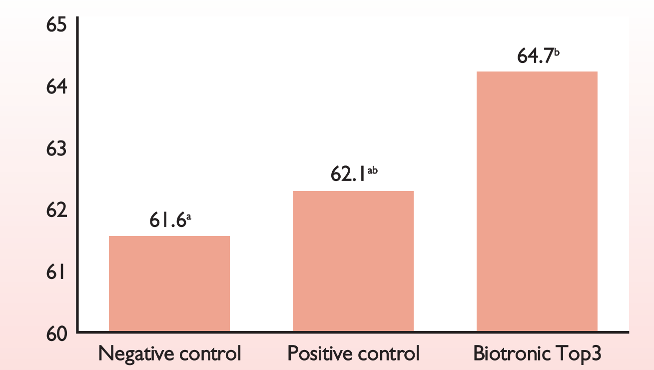
Continued on page 17

Fig. 1. Final body weight.



[a,b] means with different superscripts differ significantly ($P<0.05$)

Fig. 2. Average daily weight gain.



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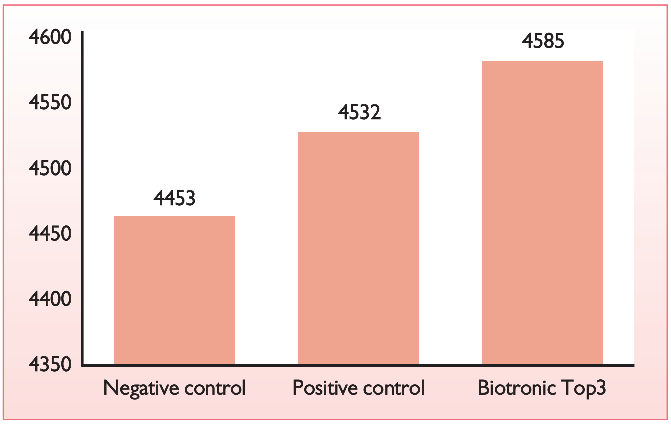


Fig. 3. Feed intake.

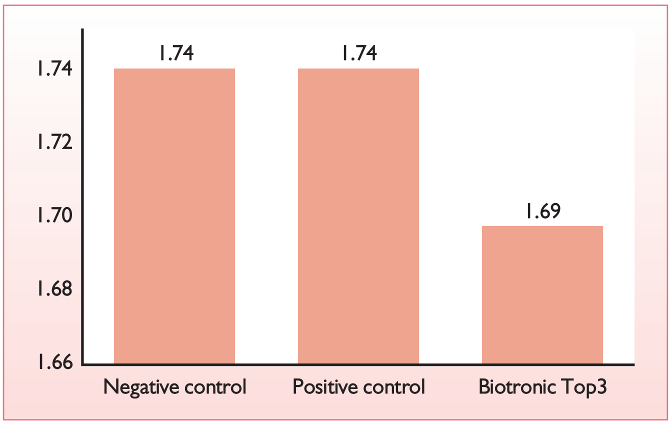


Fig. 4. Feed conversion ratio (FCR).

Continued from page 15
controlling acid blends. With the differences in pKa values there were benefits by increasing the areas of efficacy. Additionally, other organic acids, lactic, acetic, have been used in combination as a way of further developing antimicrobial activity in synergistic blends.

Phytochemicals

The benefits of herbs and spices in maintaining a healthy intestine, or treating intestinal complaints, have been known for thousands of years.

Following the banning of antibiotic growth promoters a range of products derived from the essential oils of varying herbs and spices, or combinations of essential oils, have been produced with varying degrees of success.

Whilst essential oils do have the potential to modify the intestinal microflora by their actions against pathogenic bacteria whilst promoting commensal ones; they also have additional properties.

They have the ability to stimulate the immune system, stimulate certain enzyme secretions in the intestine and protect the intestinal villi. They are also recognised for their antioxidant properties.

Study into the molecular composition of these essential oils has enabled the identification of the major active ingredients, the phytochemicals. There are many phytochemicals known, from different herbs and spices, with differing modes of action. One such is cinnamaldehyde which is derived from the cinnamon bark oil. One of the main features of cinnamaldehyde is its ability to inhibit the cell division of harmful bacteria. This is achieved by cinnamaldehyde's ability to inhibit the FtsZ protein in bacteria which polymerises into filaments to form the Z-ring and attaches to the cell wall at the point where division will occur. By inhibiting the cell division of harmful bacteria cinnamaldehyde reduces the pathogenic bacteria load in the intestine.

Both essential oils and phytochemicals have been combined with organic acids as a way to further enhance antimicrobial efficacy. In some, but not all, cases a natural synergy has been noted with combinations of different organic acid blends and either phytochemicals or essential oils

Permeabilising substance

Gram negative bacteria differ from Gram positive bacteria in that they have an additional outer membrane which provides increased resistance to hydrophobic antibiotics and detergents. This is due to there being a lipopolysaccharide layer over the cytoplasmic membrane which also makes Gram negative bacteria less susceptible to antimicrobial products.

Destabilisation of the outer lipopolysaccharide layer is possible by agents commonly called permeabilisers. This is achieved by the removal of stabilising cations from the outer membrane, binding to the outer membrane to block the barrier function or destabilising the outer membrane causing actual membrane damage.

Use of a permeabilising substance in combination with a synergistic blend of organic acids and phytochemicals will enhance the antimicrobial efficacy of the product against Gram negative bacteria, due to the destabilisation of this outer membrane. This then results in less resistance to the incorporation of the acid combination into the cell to permit the inhibition, or destruction, of cellular activity. The combination of a synergistic blend of organic acids, a phytochemical and a permeabilising agent leads to a product which is effective against a wider range of harmful bacteria, both Gram positive and Gram negative.

Broiler performance

The effects on the inhibition of bacterial growth of an acid mixture, combined with a phytochemical and the Biomin Perforizer – a permeabilising substance – in vitro was shown in research done at the Biomin Research Center in Tulln in Austria. Synergistic effects were found when adding the Biomin Perforizer to the formula of organic acids and a phytochemical, indicating that the permeabilisation of the outer membrane of Gram negative bacteria facilitates organic acids to penetrate the Gram negative cell destroying cellular functions, leading to cellular death.

This was also shown to effect animal growth performance, indicating that the host animal does not have to compete for nutrients with pathogenic bacteria.

Brazilian trial

A trial was carried out at the Federal University of Paraiba in Brazil, using 450 Cobb broilers. Birds were assigned to three treatments for 42 days and fed a corn-soybean meal based pre-starter, starter, grower and finisher diet.

The composition of the diets is shown in Table 1 and diets were formulated according to Brazilian standards.

The control group diet contained no growth promoters, whereas the diet of the positive control group contained 1kg/t zinc bacitracin, while the trial group was supplemented with the acidifier Biotronic Top3 containing an organic acid formula, a phytochemical and the Biomin Perforizer at an inclusion rate of 1.0 kg/t feed.

Differences in performance and European Production Efficiency Factor are shown in Figs. 1 to 5. Compared to the negative control group final body weight and daily weight gain were increased by 5% and the European Production Efficiency Factor by 4% in the Biotronic Top3 group. These means differed significantly (P<0.05).

Feed intake was increased by 3% in the Biotronic Top3 group compared to the negative control group.

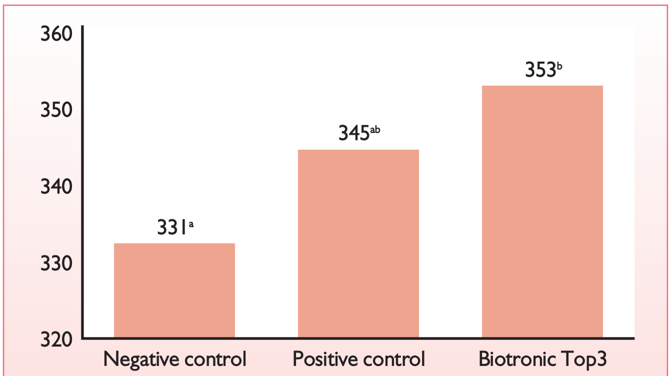
Final body weight was improved by 3%, average daily gain by 4%, feed intake by 1% and the European Production Efficiency Factor by 2% in the Biotronic Top3 compared to the positive control group.

Feed conversion ratio was improved by 3% in the Biotronic Top3 group compared to both the positive and negative control group.

In short, the synergy caused by the inclusion of the permeabilising substance boosts the effect of the other antimicrobial ingredients, resulting in an economical benefit for the end user.

Therefore, it presents a totally new strategy to act against bacteria. The company has launched the natural growth promoter as Biotronic Top3. ■

Fig. 5. European Production Efficiency Factor.*



[a,b] means with different superscripts differ significantly (P<0.05)
*European Production Efficiency Factor (EPEF) = (Liveability [%] x final body weight [kg]/age [days]/feed conversion ratio) x 100