Optimisation concept for pathogen control

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Antibiotic growth promoters have been used in animal production worldwide since 1946, when their positive effects were observed for the first time.

Antibiotic growth promoters are antibiotics added to animal feed at subtherapeutic levels to control pathogens and therefore increase growth, decrease the incidence of diseases and improve feed efficiency.

The use of antibiotics over time in animal health has resulted in the bacterial resistance to these antibiotics. The transfer of antibiotic resistant genes from animals to humans has now become evident.

A lot of attention is being focused on the problem of bacterial resistance, which has resulted in the banning and/or regulation of the use of antibiotics by a number of countries.

The development of alternative products and improved management is therefore necessary to eliminate the use of antibiotic growth promoters while maintaining productivity.

Use of organic acids

Organic acids as alternatives to antibiotic growth promoters have increasingly and successfully been supplemented in poultry feed. Acids reduce the microbial load, aid the buffering capacity and reduce the pH in the feed. The pH reducing effect of acidifiers in the foregut supports protein digestion. The reduction in gastric pH activates pepsinogen and other zymogens and brings the pH of the stomach closer to the optimum for pepsin activity.

Table 1. Performance characteristics of broilers.

	Control	NGP
Body weight (g)		
Day 1	40.22	40.12
Day 21	671^{a}	689^{b}
Day 42	1953^{a}	2048^{b}
Average daily weight gain (g)		
Day 1-21	30.04^{a}	30.94^{b}
Day 22-42	60.97^{a}	64.55^{b}
Day 1-42	45.55^{a}	47.82^{b}
Average daily feed intake (g)		
Day 1-21	45.07	45.31
Day 22-42	128.0^{a}	131.72^{b}
Day 1-42	86.54^{a}	88.51^{a}
Mortality (%)	9.50	4.50
Feed conversion ratio		
Day 1-21	1.5^{a}	1.46^{b}
Day 22-42	2.10	2.04
Day 1-42	1.90^{a}	1.87^{b}
EPEF*	221^{a}	249^{b}

NGP = Natural growth promoter consisting of formic, propionic and acetic acids, cinnamaldehyde and permeabiliser; EPEF = European Production Efficacy Factor (Livability [%] x BW[kg] / age[d] / FCR) x 100; ^{ab}Means in the same row with no common superscripts are significantly different (P<0.05)

Organic acids are well known to decrease the pathogen numbers and modulate the intestinal microbiome of poultry. In their undissociated form, they can penetrate the bacterial cell and stop bacterial growth.

The use of an organic acid mixture decreases the total bacterial count and Gram-negative bacterial count significantly in the broiler chickens. Using organic acids instead of single acids may be more beneficial as a result of a broader spectrum of activity.

Organic acids improve protein and energy digestibility by reducing microbial competition with the host for nutrients and endogenous nitrogen losses, lowering the incidence of subclinical infections and secretion of immune mediators, and reducing the production of ammonia and other growth-depressing microbial metabolites.

Creating a combination

May the efficacy of organic acids be improved and optimised? Combining organic acids with other naturally derived substances is beneficial in comparison to the use of these substances alone. Combining organic acids with plant derivatives may be beneficial due to the effect on different parts of the gastro-intestinal tract.

Organic acids would exert their activity in the feed and upper gastro-intestinal tract and plant derivatives to a greater extent in the distal part of the intestinal tract.

The phytochemical cinnamaldehyde targets the FtsZ protein, which plays an important role in the cell division of pathogenic bacteria.

Cinnamaldehyde inhibits not only the formation of FtsZ into filaments, but also the essential processes involved in the Z-ring formation, its function and thus the cell division.

This results in a reduction in the bacterial load within the gastro-intestinal tract.

Despite the fact that natural replacements for antibiotic growth promoters are known, fighting Gram-negative bacteria is a challenge. The outer membrane of Gram-negative bacteria acts as a barrier that prevents antimicrobial compounds from entering the cell and destroying vital functions.

This outer membrane can be destabilised by permeabilising substances, which make the bacterial cell more susceptible to antimicrobial compounds. Permeabilising substances damage the outer membrane of Gram-negative bacteria. This makes the bacteria more susceptible to hydrophobic antimicrobials.

The effect of organic acids and cinnamaldehyde on the inhibition of E. coli and Salmonella typhimurium can be synergistically improved by the inclusion of permeabilising substance due to an increase in outer membrane permeability.

An experiment was conducted to study the effects of dietary supple-

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mentation with a natural growth promoter (NGP) consisting of a blend of formic, acetic and propionic acids, cinnamaldehyde and permeabilising substance in a corn-soybean meal-based diet on growth performance and caecal microbiome.

Broiler trial results

The trial was conducted in a commercial broiler farm in Jiangsu Province, China. Four hundred day-old healthy AA broiler chicks were fed the commercial diets. Chicks had ad libitum access to feed and water.

All birds were randomly assigned to two treatments with four replicates in each treatment and 50 broilers (half male and half female) in each replicate.

A negative control group received no growth promoters, whereas a trial group received 1kg NGP per ton of feed. The feeding trial lasted for 42 days. Body weight (BW) of the individual animals and feed intake were measured and recorded on days 1, 21 and 42. Morbidity rates and mortality rates were recorded as they occurred.

The feed conversion rate (FCR) was also calculated. At 21 and 42 days of age, eight animals from each group were randomly selected for sampling and slaughtered. The counts of E. coli, Salmonella spp., Clostridium perfingens and Lactobacillus spp. in the caecal content were analysed.

Growth performance was improved due to the supplementation of diets with NGP (Table 1). BW at day 21 and at day 42 was higher (P<0.05) in the NGP group in comparison with the control group.

Also the average daily weight gain (ADWG), and average daily feed intake (ADFI) of the NGP group were higher (P<0.05), than the control group at day 42. FCR was improved in the NGP group in comparison with the control group at day 42. Calculated EPEF was higher (P<0.05) in the NGP group than in the control group.

	Control	NGP
Day 21		
E. coli	8.356^{a}	7.643^{b}
Salmonella spp.	7.325^{a}	6.781^{b}
Lactobacillus spp.	7.825^{A}	8.827^{B}
Clostridium perfingens	7.901^{a}	7.497^{b}
Day 42		
E. coli	8.455^{a}	7.842^{b}
Salmonella spp.	7.287^{a}	6.812^{b}
Lactobacillus spp.	8.262^{A}	9.115^{B}
Clostridium perfingens	8.545^{A}	7.798^{b}

NGP = Natural growth promoter consisting of formic, propionic and acetic acids, cinnamaldehyde and permeabiliser; ^{ab}Means in the same row with no common superscripts are significantly different (P<0.05); ^{AB}Means in the same row with no common superscripts are significantly different (P<0.01).

Table 2. E. coli, Salmonella spp., Lactobacillus spp. and Clostridium perfringens count in caecum, lg(CFU/g).

Efficacy of the combination

Effects of NGP on the level of E. coli, Salmonella spp., Lactobacillus spp. and Clostridium perfringens in broilers are presented in Table 2.

The counts of E. coli, Salmonella spp., and Clostridium perfringens in the NGP group were lower (P<0.05) than those in the control group on day 21 and day 42.

The counts of Lactobacillus spp. in the NGP group on day 21 and day 42 were higher (P<0.05) than those in the control group (P<0.01) on day 21 and day 42.

The results showed that supplementing the poultry diet with NGP increased poultry growth performance improving the final weight, average daily gain and feed conversion ratio.

The NGP increased the amount of Lactobacillus spp., and decreased the amount of E. coli, Salmonella spp. and Clostridium perfringens in the caecum. These results of the present study might indicate the improved growth performance in broilers due to the change in the intestinal microbiome by inhibiting pathogenic bacteria while supporting beneficial bacteria. ■