Natural growth promoters for

The ban of antibiotics has driven the worldwide implementation of alternative strategies in order to prevent proliferation of pathogenic bacteria. Several approaches have been developed to directly affect microbial communities in the digestive tract and to prevent the gut from invasion by pathogenic organisms. A rapid establishment of a beneficial gut microflora assists in maintaining bird health throughout the growth period.

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Several feeding strategies can assist in promoting health and performance, without using antibiotics.

In the recent decades, deficiencies in feed formulation and management practices have been masked by the routine use of Antibiotic Growth Promoters (AGPs). However, the ban of AGPs in Europe has driven the implementation of alternative strategies in order to prevent proliferation of pathogenic bacteria, thus maintaining health and performance status and optimising digestion in poultry production. A stable gut microflora, predominantly composed of lactic acid-producing bacteria and protecting the host from pathogenic invasion, is a prerequisite for gut health and adequate growth performance. Several feed additives have been used to manipulate microbial communities in the digestive tract. However, their efficacy has not always been proven and their modes of action require further research.

The present paper focuses on the role of Natural Growth Promoters (NGPs) as potential modulators of gut health and growth performance in modern poultry production.

Acidifiers preserve feed

Even under good hygienic conditions, feedstuffs contain a certain number of moulds, bacteria and yeasts. Some mould species (e.g. *Aspergillus*, *Penicillium*, *Fusarium*) are known to produce mycotoxins that may negatively affect health and growth performance. Acidifiers may be used to avoid microbial deterioration of feed during storage. Moreover, increased growth performance has been observed when acidifiers are added to feed. The positive impact of dietary acidifiers on gut health and growth performance has been attributed to: (1) a reduction of the pH values in the feed and digestive tract, serving as a barrier against pathogenic microorganisms which are sensitive to low pH values; (2) the direct antimicrobial effect; (3) the reduction in buffering capacity in conjunction with increased protein digestibility.

The efficiency of organic acids largely depends on their pK_a value (the pH value at which 50% of the acid is dissociated). Low pK_a values (e.g. citric, formic acid) generally indicate a strong pH-decreasing impact, whereas a pronounced antimicrobial effect is obtained at higher pK_a values (e.g. propionic, butyric acid). The combination of acidifiers with different pK_a values may, therefore, exert synergistic effects and maximise the beneficial impact of supplementation with organic acid on gut health and growth performance.

Few studies have been carried out that investigated the efficacy of acidifiers as NGP in poultry nutrition. Lückstädt *et al.* (2004) examined the efficacy of a blend of propionic acid and formic acid based on an inorganic phyllo-silicate carrier (Biotronic®) in broilers. As shown in *Figure 1*, the acidifier significantly increased live weight throughout the experiment.

Establishing a beneficial gut microflora

Immediately after birth, the gut of neonate chicks is colonised by a large number of microorganisms originating from the environment. Age and physiological state of the birds, as well as the dietary composition, may affect the gut microflora, both in quantitative and qualitative terms.

Oral administration of beneficial bacteria (probiotics) assists in rapidly establishing a beneficial gut microflora, which is generally characterised by high levels of lactic acid-producing bacteria. The beneficial impact of probiotics is attributed to: the competition with pathogens for nutrients and adhesion sites; the production of antagonistic substances (such as lactoferrin, lysozyme, hydrogen peroxide, lactic acid or other organic acids); and immune modulation through induction of cytokines or stimulation of macrophages and antibodies.

Establishment of a beneficial gut microflora largely depends on the dietary ingredient composition. Several carbohydrates (prebiotics), which are resistant to host digestive enzymes, have been shown to stimulate growth of beneficial bacteria, such as *Bifidobacteria* or *Lactobacilli*. Such carbohydrates include, among others, inulin, fructo-oligosaccharides (FOS) or galacto-oligosaccharides. In studies with 240 day-old broilers, FOS increased the growth rates of *Bifidobacteria* and *Lactobacilli* and also inhibited *E. coli* in the small intestine and caeca of broiler chicks. In this study, birds were fed a corn-soybean meal-based diet supplemented with graded doses of FOS (0, 2, 4 or 8g/kg of finished feed) at the expense of corn. Moreover, the addition of FOS increased activities of endogenous amylase and protease, as well as jejunal and ileal microvillus height and, finally, improved body weight gain and feed conversion ratio. The improvements were maximal in magnitude when FOS was added at 4g/kg, indicating a distinct dose-dependency of the parameters that were investigated. In a study with turkeys it was discovered that dietary supplementation of inulin significantly reduced the population of *E. coli* in the caeca and tended to increase numbers of *Bifidobacteria* and *Lactobacilli*.

A synergistic effect may be expected if probiotics and prebiotic carbohydrates

gut health management

Figure 1 - Effect of an acidifier (Biotronic®) on live weight in broilers (*n* = 120) (Lückstädt *et al.*, 2004)

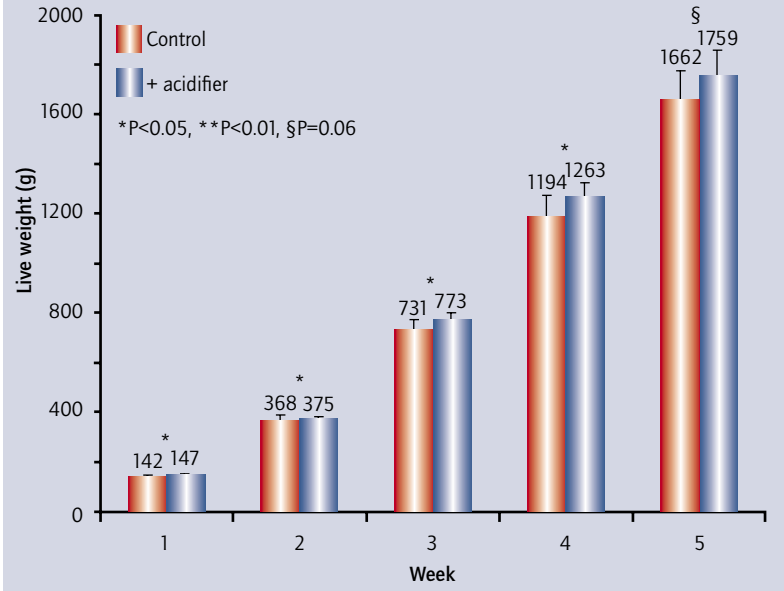


Figure 2 - Impact of synbiotics and an antimicrobial growth promoters (AGP) on caecal counts of different bacterial species (Mountzouris *et al.*, 2006)

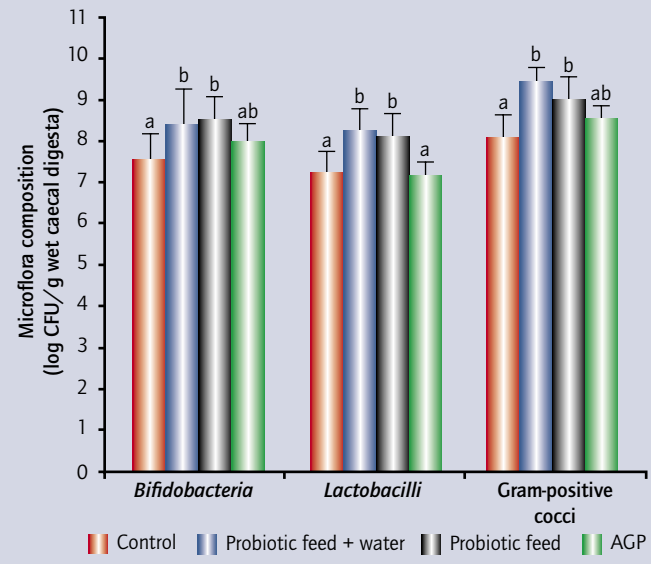


Figure 3 - Effect of a commercial synbiotic preparation on performance parameters in broilers

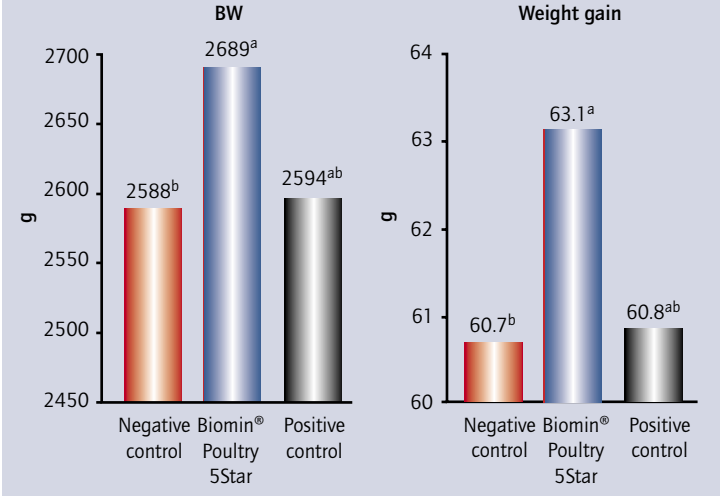
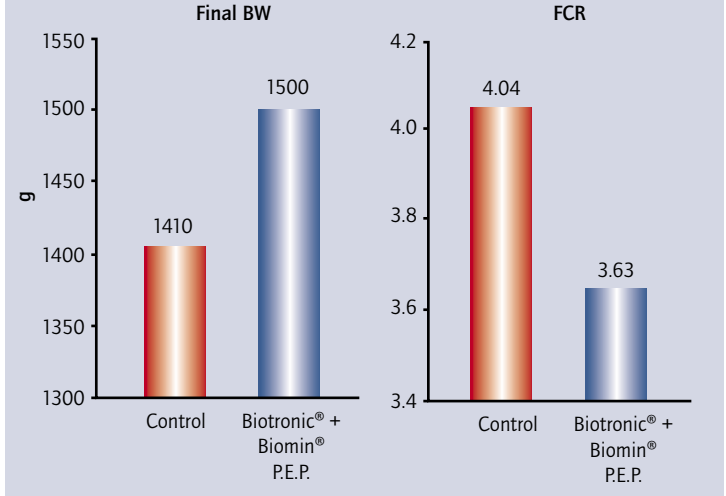


Figure 4 - Effect of an acidifier and phytogenics on performance parameters in broilers



are administrated in combination.

The impact of synbiotics in comparison to AGPs on gut microflora of broilers has been demonstrated by researchers from the University of Athens in Greece (*Figure 2*). They fed 400 day-old broilers corn-soybean meal-based diets with or without supplementation of either a multi-strain probiotic feed additive based on *Lactobacilli*, *Bifidobacteria*, *Enterococcus* and *Pediococcus* (Biomin® Poultry5Star) or a commercial AGP (Avilamycin). Compared to the control and AGP treatment, the probiotic additive significantly increased the numbers of *Bifidobacteria*, *Lactobacilli* and Gram-positive cocci. Moreover, growth performance in birds fed supplemental synbiotics was similar ($P > 0.05$) as compared to birds fed the AGP.

The effect on growth performance of the same commercial synbiotic preparation was investigated in another study with 200 day-old broilers. Here it was discovered that administration of the synbiotic in drinking water significantly improved live weight (4%) and daily weight gain (4%) (*Figure 3*) and numerically reduced mortality rate (48%).

Phytogenics have potential

A comparatively new category of NGPs originating from herbs and spices has received growing attention in recent years. Phytogenics are extremely inhomogeneous regarding their ingredient composition and levels of active substances. Phytogenic components, such as carvacrol, thymol or cinnamaldehyde, have

strong antimicrobial, antioxidant and flavouring properties. Moreover, it has been speculated that phytogenics may stimulate secretion of saliva and digestive enzymes. The impact of a blend of essential oils originating from oregano, clove and anise in comparison to a conventional AGP (Avilamycin) was investigated in a trial with broilers. The phytogenic, fed at graded doses (0, 100, 200, 400 ppm), significantly improved average daily weight gain and gain:feed ratio and these improvements were even higher in magnitude in comparison to the AGP. The effects of phytogenic supplementation were highest at a dosage of 200 ppm, indicating a close dose-dependency between performance parameters and the level of supplemental phytogenics. Additionally, there was an increase in feed intake following administration of the phytogenic after three experimental weeks. In a 120-day trial with broilers, the combined administration of acidifiers and phytogenics increased weight gain and reduced feed:gain ratio in comparison with a control treatment (*Figure 4*).

NSP-degrading feed enzymes

Barley, oats, rye, triticale or wheat contain significant amounts of soluble Non-Starch Polysaccharides (NSP). Inclusion of these grains in diets for poultry produces sticky droppings and poor litter quality. Thus, enzymes specifically tailored to decrease gut viscosity (e.g. ß-glucanases, xylanases, pectinases, cellulases and others) are recommended in diets for broilers, layers and turkeys. Supplementation of cereal-based diets with NSP-degrading enzymes, which target the soluble NSP fraction, results in a decrease in digesta viscosity and water-holding capacity. Consequently, the transit of digesta in the gut is accelerated, which, in turn, may stimulate voluntary feed intake. It is assumed that a reduction in digesta viscosity improves the rate of diffusion between host digestive enzymes (proteases, lipases, amylases) and nutrients, resulting in increased nutrient digestibility and energy availability. Supplementation of wheat-based control diets with an enzyme cocktail containing ß-glucanase, xylanase, cellulase and other side activities significantly reduces digesta viscosity in the jejunum of broilers (2.5 vs. 5.0 mPa.s). Moreover, the addition of NSP-degrading enzymes significantly reduced the concentration of soluble and insoluble NSP in the digesta of broilers, thereby improving ileal digestibility of NSP, fat, starch and nitrogen. In studies with broilers, supplementation of wheat-based diets with xylanase preparations originating from different fungal sources improved average daily weight gain and feed conversion rate by 4-14% and 4-9%, respectively. However, the response of these parameters clearly depend on the origin of the supplemental enzymes, indicating differences in substrate specificity between different sources of NSP-degrading enzymes.

Conclusion

Several feeding strategies may be implemented to assist in promoting health and performance status in poultry production. Acidification of diets prevents microbial contamination and may stimulate growth performance. Combined administration of probiotics and prebiotics has the potential to accelerate the establishment of a beneficial gut microflora, which protects the host from the invasion of pathogens. Supplementation of diets with specific NSP-degrading enzymes improves litter quality, as well as nutrient and energy digestibilities. The use of phytogenics may stabilise the gut microflora to a certain extent. Most of the effects of the NGPs depend on the age of the animals as well as on the dosages at which these ingredients are included in the feed. ■