Full natural phytogenic support for intestinal resilience in poultry

As defined by the World Organisation for Animal Health, 'an animal is in a good state of welfare if it is healthy, comfortable, well-nourished, safe, able to express innate behaviour, and not suffering from unpleasant states such as pain, fear, and distress'.

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The poultry industry struggles with significant problems previously controlled by antibiotic growth promoters after the European Union's ban on AGPs, a fear of growing resistance among parasites, and environmental residues due to anticoccidial drugs. This encouraged the Federation of Veterinarians of Europe in 2016 to publish a position paper on coccidiostats or anticoccidials, recommending strict veterinary supervision of their use.

Since most of the problems that threaten animal health are multifactorial, there is no single solution. So, there is a need for a holistic approach to poultry production and possibly for the implementation of a combination of different types of feed additives to break the vicious cycle of disease and improve the overall performance of poultry. A variety of available alternatives is considered safe by consumers, among which phytogenics play a significant role.

Phytogenics are biologically active compounds that have attracted increased interest as feed additives in poultry production and have been primarily tested to identify their effects on birds' gastrointestinal function and health.

Phytogenic feed additives (PFAs) originating from plants consisting of herbs, spices, fruit, and other plant parts, include many different bioactive ingredients that may promote feed efficiency with the regulation of gastrointestinal tract (GIT) function.

By enhancing the production of digestive secretions and nutrient absorption, encouraging balanced microbiota, and supporting good immune status, PFAs may improve the animal's health status. The continuous interaction determines this among diet, intestinal integrity, gut microbiome, and the immune system of chickens.

Regulation of microbiota and villus-crypt ratio

The intestinal barrier system consists of several components: a layer of mucus, gut microbiota, elements of the immunological system, and, most importantly, adjacent intestinal epithelial cells, which remain in dynamic interaction with each other and the environment.

The integrity and permeability of the intestinal barrier are maintained mainly by the unimpaired epithelial cells monolayer and the functional intercellular junctions (tight junctions (TJ), adherens junctions, and desmosomes) between them. They play an essential role in the first line of defence against pathogen and toxin invasion. High villus (V) and deep crypts (C) of the mucosa signify an increased V:C ratio indicating the presence of mature enterocytes, balanced enterocyte migration and sloughing, and efficient nutrient absorption for growth.

Heat and overcrowding stress, glucocorticoid challenge, or a high-fat diet leads to systemic and intestinal inflammation once the mucus layer and TJ barriers in the small intestine are destroyed, triggering various chronic diseases through pathogen invasion.

The GIT of healthy chickens is densely harboured by complex microbial communities which provide both nutrition and protection for the animal.

Commensal microbiota stimulates the immune system's development, including the mucus layer, and forms a protective barrier between the host and the microbes.

In case of impaired digestion and absorption, a delivery of excess nutrients (such as starch, protein, and fat) to the distal segments of the gastrointestinal tract induces alterations in the GIT microbial community resulting in a qualitative and quantitative imbalance of normal microbiota in the distal segments of the chicken's intestine.

The AGPs withdrawal is associated with gut health impairment, such as an increase in the feed conversion ratio, the reemergence of previously controlled diseases like necrotic enteritis, coccidiosis, wet litter, or leaky gut syndrome, and the occurrence of illnesses caused by commensal microbiota capable of crossing the intestinal barrier due to its reduced integrity.

Since the diet is the main factor modulating the composition and the metabolic activity of the GIT microbiota, several feed additives have been developed focusing on enhancing immune response and promoting the colonisation of the GIT with beneficial bacteria, thus stimulating digestion and absorption.

Protection against oxidative and inflammatory processes

The maintenance of GIT integrity is crucial to ensure an effective immune system since it is the largest organ of the immune system that plays a pivotal physiological role as a barrier against antigens and pathogens. Several phytogenics were reported to have a host-mediated immunomodulatory effect, either as immunosuppressors or immunostimulators.

Several in vivo trials in the literature confirm that PFAs can modulate immune responses through various mechanisms through interactions with the immune system. One of those mechanisms is the modulation of cytokine expression, which plays a crucial role in both the adaptive and the innate immune system alternatives.

Some phytogenics regulate the expression of pro-inflammatory mediators and enzymes involved in the NF-κB and mitogen-activated protein kinase signalling pathways. In

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Table 1. Necrotic enteritis lesion score, necrotic enteritis mortality (%), and oocysts excretion (oocyst per g faeces, OPG) observed at 21 days (Delacon, USA 2018).

Treatments	Lesion score	Mortality	OPG
Non-infected, non-treated	0.0[c]	0	89,000[a]
Infected, non-treated	1.1[a]	14[a]	80,500[a]
Infected plus BMD	0.7[b]	2.3[c]	90,600[a]
Infected plus Biostrong Protect	0.5[b]	2.3[c]	46,200[b]

[a,b,c] Different letters indicate statistical difference (P<0.05)

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contrast, others modulate the anti-inflammatory response by inhibiting lipoxygenase, prostaglandins, and leukotrienes or inhibiting the secretion of pro-inflammatory cytokines.

Phytogenics can also reduce excessive oxidative stress by lowering plasma lipid peroxidation and malondialdehyde (MDA) levels. There is a tight connection between antioxidant and anti-inflammatory function, as reactive oxygen species (ROS) are involved in a broad spectrum of diseases, including chronic inflammation.

The antioxidant mechanism of action mediated by phytogenics could also explain their anti-inflammatory properties. Dietary immunomodulation is a key to enhancing the productivity and immune system integrity of poultry raised in the absence of antibiotics.

Quorum sensing

Quorum sensing means bacterial cell-to-cell communication, a mechanism by which bacteria can communicate with cells of their species and other species by small, diffusible molecules called autoinducers to detect modifications in their surrounding environment. This autoinducer plays a crucial role in regulating niche-specific behaviour such as biofilm formation, cell division, motility, and virulence in commensal and pathogenic bacteria. Different pathogenic bacteria (for example E. coli, salmonella, clostridium) use quorum sensing to successfully colonise complex environments such as the gut.

Recent studies on bacterial biofilms and virulence factors modulated by natural products have received increasing attention, such as controlling the formation of biofilms and the production of virulence factors by affecting the expression of related genes and through competitive binding with signalling molecules.

Natural compounds regulate QS between bacteria by controlling gene expression, biofilm formation, and the production of virulence factors.

Efficacy of phytogenics in mitigating gut challenges

A floor pen trial study was conducted at Southern Poultry Research Station in Athens (the USA) in 2018 to study the effectiveness of Biostrong Protect on growth performance, the severity of necrotic enteritis, and oocyst excretion in broilers.

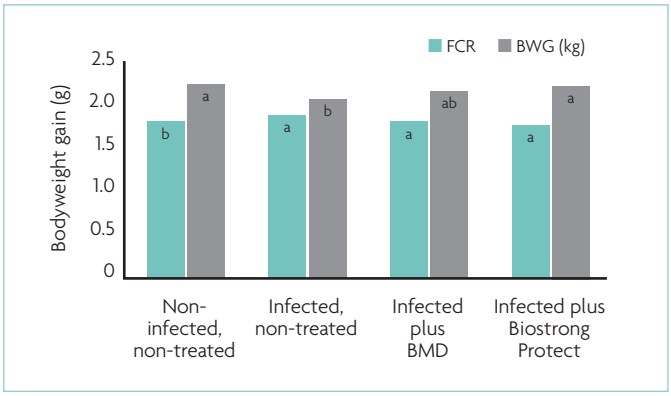

Fig. 1. Bodyweight gain (BWG, g) and feed conversion ratio (FCR, mortality corrected) of broilers from 1-42 days (the USA, 2018).

350 Cobb 500 male broilers were vaccinated with Coccivac-B52 alone (non-infected, non-treated) or subsequently challenged at days 19, 20, and 21 with Clostridium perfringens and non-treated (infected, non-treated) or supplemented with bacitracin (BMD) and with Biostrong Protect.

A three-phase corn/soy diet was fed ad libitum during the entire experimental period.

In the presented trial, dietary supplementation of Biostrong Protect at 400g/t reduced feed conversion ratio (FCR) by five points over the 42-day experimental period. Oocyst excretion (OPG: oocyst/g faeces) was reduced by 43% in the Biostrong Protect group from 80,500 to 46,200.

The necrotic enteritis lesion score of birds supplemented with Biostrong Protect was 0.5 and significantly lower than the non-medicated groups. Therefore, the improved resilience against coccidiosis and lower necrotic enteritis lesion score with Biostrong Protect may result in reduced severity of secondary infections, similar to the AGP bacitracin. ■