

How to achieve sustainable antibiotic-free broiler production



by **Predrag Persak**, Regional Technical Manager North Europe, EW Nutrition

The main sustainability challenge for broiler production lies in securing enough high-quality, nutritious, safe, and readily available food at a reasonable cost. At times, feed ingredients have to be included that are not nutritionally ideal and might compromise one's broilers' health and wellbeing. However, counteracting this threat with prophylactic antibiotics is not acceptable: We must minimize the use of antibiotics to mitigate antimicrobial resistance. The way forward is to go beyond static and linear nutritional value-to-price thinking. A dynamic nutritional strategy focusing on the interdependencies between ingredients, gut, microbiome, and digestion, enables sustainable ABF broiler production.



Sustainable ABF broiler production requires a dynamic, gut health-oriented nutritional strategy

Sustainability vs. ABF production - is there a trade-off?

The [United Nations' 1987 Brundtland report](#) offers a clear definition of sustainability as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” “Ability” includes the availability of resources – and in broiler production, which is one of the most efficient livestock productions, resources have always been a top priority. As a constantly evolving industry, broiler production has been quick to adopt sustainability into its management strategies. The use of the resource that is antibiotics, however, poses particular challenges.

Humans and animals depend on [antibiotics to fight microbial infections](#). It is essential to maintain their efficacy so that future generations can lead healthy lives. Antibiotic efficacy is under threat from the [development of antimicrobial resistance](#), which emerges from overuse and misuse in both human and veterinary medicine. Across the globe, broilers are still raised with the assistance of antibiotics. Either for disease therapy, to prevent disease occurrence, and still, in some parts of the world, to enhance performance. Driven by regulatory and consumer demands, broiler production with minimal or no use of antibiotics is rapidly gaining importance.

The challenges of antibiotic-free broiler

production

ABF systems encounter numerous challenges since production requirements change drastically. Stock density must be lower; it takes longer to reach the desired weight; and more feed is needed to produce the same amount, with a higher risk of morbidity and mortality ([Cervantes, 2015](#)). The latter can result in more birds needing treatment with medically important antimicrobial drugs. All those challenges need to be overcome by adopting suitable strategies related to nutrition, genetics, management, biosecurity, welfare, and food safety.

As animal nutritionists, our focus lies on nutrition, feed, feed materials, additives, feed processing, feeding, and their (positive or negative) influence on the sustainability of ABF broiler production. However, we cannot look at these dimensions of production as a separate process. They are linked in the whole food chain and are affected by changes that happen in other related parts. An obvious example is feed production, which has an enormous impact on the overall sustainability of ABF broiler production:

- Due to raw material shortages, diets are becoming ever more complex, containing more single feed ingredients. For some of them, we need a better understanding of their impact on ABF broiler production (e.g., sunflower, rapeseed, beans, lupins).
- The nutritional composition of raw materials changes due to limitations in fertilizer use, and variability within the same raw material group is expected to increase.
- New food waste-reducing feed materials can enhance feed security but also require nutritional profiling to integrate them into diets.
- [Local feed material production](#) in humid and warm environments can introduce various pathogens into the feed/food chain.
- Increases in known and the emergence of new antinutrients and feed components that impair animal health, performance, and feed efficiency.
- Sustainability-driven pesticide reduction raises concerns about [mycotoxins contaminating feed ingredients](#).
- Nutrient reduction to support gut health and, primarily, lower the excretion of nitrogen and phosphorous, negatively affects growth, nutritional standards, and the ability to freely select feed materials to include in broiler diets.
- The value (of which price is also part) of raw materials will be compromised, due to availability and nutritional variability.



Mycotoxin contaminated-feed can damage production animals' performance, health, and welfare

When striving for a sustainable ABF broiler production approach, the possibility for errors becomes higher, while the error margin becomes smaller. The solution lies in helping the animals to mitigate the impact of stressors by focusing on the interaction of ingredients, gut, microbiome, and digestion. It is a holistic approach centered on gut health. Keeping the intestines BEAUTiful will help you produce in challenging conditions without the use of antimicrobials.

Keep the broiler gut BEAUTiful and resilient to stress

The BEAUTiful formula captures the six areas producers need to target for supporting broiler gut health:

| B | E | A | U | T | I |
|----------|---------------------|------------|-------------------|-----------|----------|
| Barrier | Enzymatic digestion | Absorption | United microbiome | Transport | Immunity |

Barrier

If it's working correctly, the effective gatekeeper knows what gets in and what stays out. When the barrier function is compromised due to stress, pathogens can cause infections, disrupt health, and negatively impact broiler immunity. Necrotic enteritis, femoral head necrosis, and bacterial chondronecrosis with osteomyelitis (BCO) are common diseases that affect today's broiler production ([Wideman, 2015](#)). As the source of nutrients, feed serves as a modulator of various physiological functions in the intestinal tract, including intestinal barrier function.

Enzymatic digestion

The gut is where endogenous and exogenous enzymes perform their hydrolysis functions to break down complex nutrients into the parts that can be used either by the intestinal tissue itself or for the whole animal. One part of hybrid enzymatic digestion is the fermentation by commensal microbes, in which complex materials form end-products of high biological values (such as short-chain fatty acids, SCFA).

Absorption

Maintaining the gut's resorptive capacity is essential to secure the total intake of digested nutrients. Otherwise, pathogenic bacteria might use the excess nutrients to grow, form toxins, and affect the birds' health and productivity.

United microbiome

The intestine of a broiler chicken is colonized by more than 800 species of bacteria and other inhabitants, such as viruses and simple organisms that are still unknown. By competitive exclusion and secretion of bacteriocins (volatile fatty acids, organic acids, and natural antimicrobial compounds), commensal bacteria keep the host safe from an overgrowth of dangerous bacteria (e.g., *Salmonella*, *Campylobacter*, and *Clostridium perfringens*). The fine-tuned diversity in the intestinal flora and balance in all interactions between it, the host, and the ingesta are needed for birds to stay healthy and perform well.

Transport

Birds' digestive tract volumes are smaller than those of mammals with similar body weight. This means that they achieve more efficient nutrient digestion in a shorter retention time, averaging between 5 and 6 hours. Passing the small intestine usually takes around 3 hours, of which 1 hour is spent in the duodenum and jejunum. Transport times are affected by the feeding system and the extent to which material enters the caeca. Reflux of material from the distal to the proximal small intestine is an important feature that helps digestion and maintenance of a healthy gut.

Immunity

The intestinal microbiota is critically important for the development and stimulation of the immune system. The intestine is the key immunological organ, comprised of myeloid and lymphoid cells, and a site for producing many immune cell types needed to initiate and mediate immunity. Together with the microbiome, dendritic cells induce antigen-specific responses and form immunoglobulin A, which works in the intestinal lumen.

Natural gut health solution for sustainable ABF broiler production

In practice, supporting broiler gut health requires a holistic approach that includes natural feed additive solutions. [Phytomolecules](#) are compounds that certain plants develop as defense mechanisms. Phytomolecules-based solutions should feature prominently in sustainable ABF broiler production approaches due to their advantageous properties:

Enhance digestion, manage variability

Sustainability necessitates efficient resource utilization. Digestion support needs to be a priority to use the available feed in its entirety. This is particularly important if antibiotic use needs to be minimized: a maximum of nutrients should be utilized by the animal; otherwise, they feed potentially harmful bacteria, necessitating antibiotic treatments. Enhancing digestibility is the focus when we are dealing with variable feed materials or feed changes that represent stress to the animal. Selected phytomolecules have proven efficient at improving performance due to enhanced digestion ([Zhai et al. 2018](#)).

Work on microbiome and pathogens

The antimicrobial activity of certain phytomolecules can prevent the overgrowth of pathogens in the [gastrointestinal tract](#), thereby reducing dysbacteriosis ([Liu et al., 2018](#)) and specific diseases such as [necrotic enteritis](#). Studies on broilers show that they also reduce the adhesion of pathogens to the wall of the intestine. Certain phytomolecules even possess antimicrobial characteristics [against antibiotic-resistant pathogens](#).

Keep gut integrity

Phytomolecules help maintain tight junction integrity, thus preventing leaky gut ([Li et al., 2009](#)). As a result, the potential flow of [bacteria and their toxins](#) from the gut lumen into the bloodstream is mitigated. Their properties thus make phytomolecules a promising alternative to the non-therapeutic use of antibiotics.

Trial results: Phytomolecules enhance broiler gut health

To test the efficacy of phytomolecules, we conducted a large-scale field study in Brazil, under practical conditions. The focus was on growth performance, and no growth-promoting antibiotics were used. Lasting 5 months, the trial involved more than 2 million broilers. The birds were divided into a control and a trial group, with two repetitions per group. Both groups were fed the standard feed of the farm. The trial group additionally received 100g of Activo per MT in its finisher feed for 3 weeks. The study clearly shows that Activo supplementation improves performance parameters (daily weight gain, average total gain, and improved feed efficiency), which resulted in a higher production efficiency factor (PEF):

- Activo groups had a 3 % higher average daily weight gain and reached their slaughtering age earlier
- The final weight of Activo groups was about 2.5 % higher than in the control group
- With a 2 points better feed conversion, the animals of the Activo group achieved a 13.67 points higher PEF

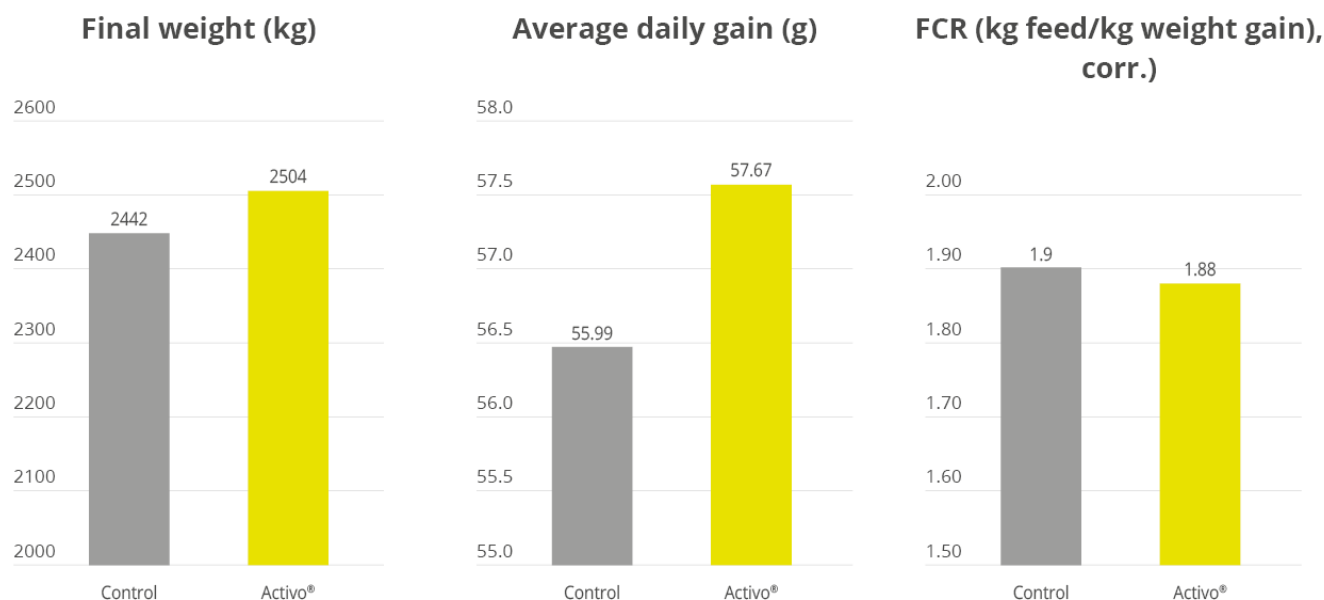


Figure 1: Broiler performance results, Activo vs. non-supplemented control group

Conclusion

Antibiotic-free broiler production is a challenging endeavor: producers need to maintain animal welfare and keep up efficiency while making farming profitable. Over time, these challenges will affect producers even more as sustainability requirements increase across all parts of the broiler production chain. On top of that, coccidiostats, which are essential for efficient broiler production, are increasingly being questioned, which will require concerted research into feed additive solutions.

To make sustainable ABF broiler production the norm, it is unavoidable to adopt suitable strategies related to nutrition, genetics, management, biosecurity, welfare, and food safety. Effective, scientifically and practically proven tools already exist: Thanks to their positive impact on intestinal health, phytomolecules reliably support sustainable broiler production without antibiotics.

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Want better poultry performance? Focus on gut health



by **Ruturaj Patil**, Product Manager Phytogenic Liquids, EW Nutrition

Commercial poultry operations have undergone enormous changes in production practices over the last 50 years. Genetic selection for high production rates, along with upgraded management techniques and dietary measures, have led to increased performance standards in all poultry operations ([Kogut et al., 2017](#)). However, it is sensible to now look into whether poultry performance may soon reach a ceiling due to genetic and/or physiological limits. So, aiming at further performance optimization, poultry researchers and producers are now focusing on gut health.



LOWRES IMG

Gut health management is key to sustainably improve poultry performance

The caveat, of course, is that, due to concerns [about antimicrobial resistance](#), antimicrobial growth promoters (AGPs) no longer offer the easy answer to gut health issues they once were. To preserve antibiotics' efficacy for cases where they are indispensable, gut health-oriented performance enhancement needs to come from other sources. This article reviews the principles of gut health management in poultry and shows how Activo liquid, a phytomolecules-based in-water solution, strengthens poultry performance by targeting gut health.

Gut health: the cradle of poultry performance

[Gastrointestinal health](#) in poultry birds encompasses three dimensions: microflora balance, gut structural integrity, and immune system status. The gut plays a vital and diverse role as it hosts most microorganisms in the body, contains more than twenty different hormones, digests and absorbs the nutrients, and accounts for 20% of body energy expenditure ([Choct, 2021](#)). When gut health is compromised, digestion and nutrient absorption are affected, with likely detrimental effects on feed conversion, followed by economic loss and greater disease susceptibility. Disease resistance and nutrient utilization largely depend on maintaining a beneficial gut antioxidant status, improving gut integrity, and modulating the gut microbiota ([Oviedo-Rondón, 2019](#)).

In birds, the gut is separated into five distinct regions (Figure 1): crop, proventriculus, gizzard, small intestine (duodenum, jejunum, and ileum), and large intestine (ceca, cloaca, and vent). Each of these regions has a specific role in the secretion of digestive juices and enzymes, the grinding of feed particles and then the digestion and absorption of nutrients ([Bailey 2019](#)).

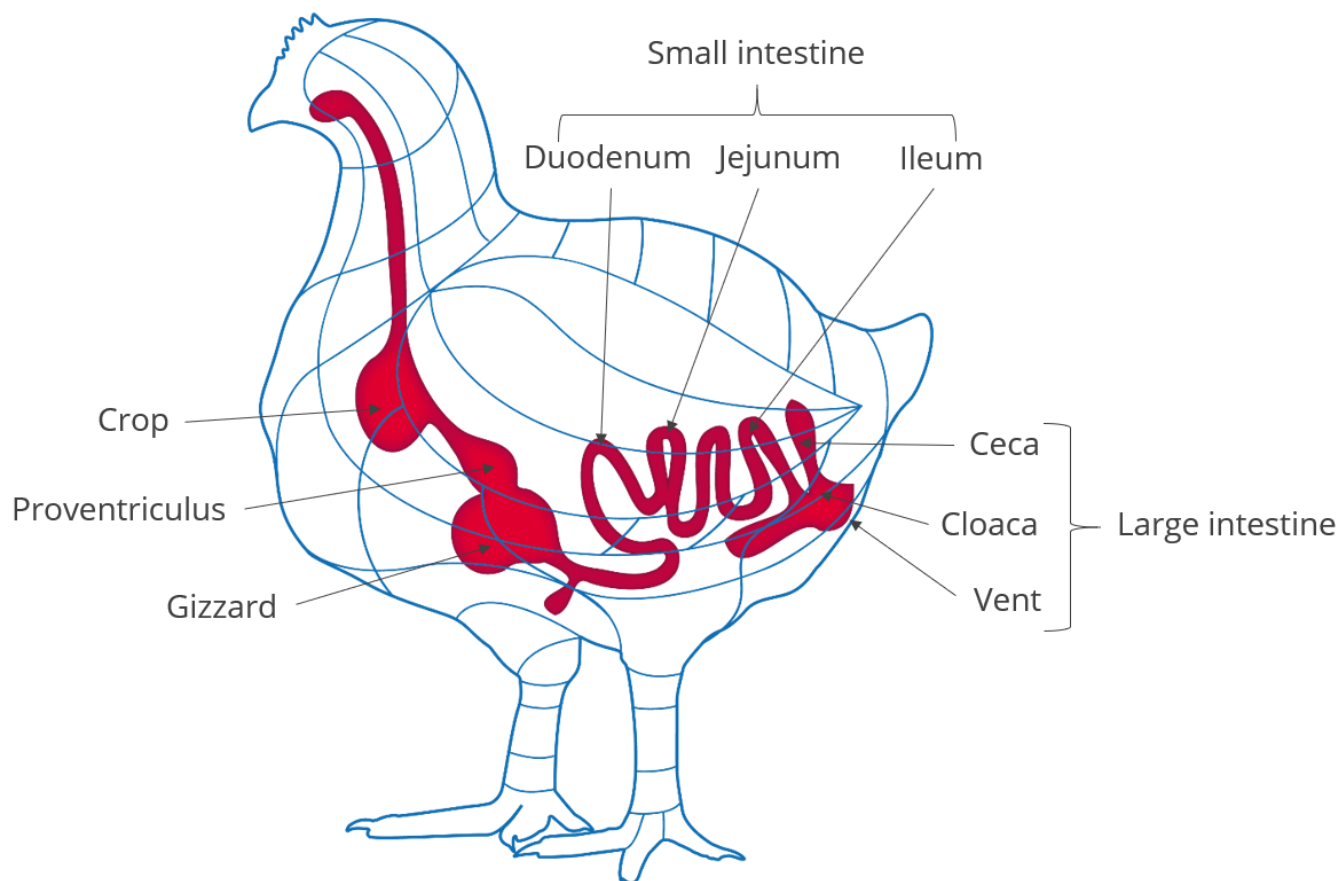


Figure 1: Schematic overview of poultry gastrointestinal tract

Factors affecting gut health

Gut health is influenced by the balance between the physiological health status of host, the gut microbiota, and a range of specific factors, all of which producers need to consider. From a management perspective, key factors encompass deprived gut health, biosecurity, and production stress, which is elevated during certain critical stages (see table 1). Environmental factors include humidity, temperature, and ventilation. Dietary factors, such as feed and water quality, feed composition, and mycotoxin contamination, also impact the development and ongoing state of poultry birds' intestinal microbiota.

| Critical stages | | Signs and symptoms |
|--|---|--|
| Broilers <ul style="list-style-type: none"> • Vaccination • Feed change • Heat/cold stress • Finisher stage | Layers/breeders <ul style="list-style-type: none"> • Vaccination • Feed change • Transition from grower to laying house • Point of lay to peak production • Late laying phase | <ul style="list-style-type: none"> • Diarrhea • Undigested feed in feces • Subclinical necrotic enteritis / cocci • Wet litter condition / food pad lesions • Increased mortality |

Table 1: Critical stages for gut health issues in poultry birds

The future is here: antibiotic reduction through improved gut health

There is a strong trend towards antibiotic-free (ABF) poultry production, fueled by AGP bans in certain regions (such as the European Union) and increasing consumer interest in avoiding products containing traces of AGPs. ABF systems can be profitable as long as the prices for the final ABF products can cover the investment costs necessary to produce these products. Larger-scale, sustainable ABF production will depend on developing a more profound understanding of intestinal health alongside the development of practical applications that [foster gut health](#) throughout each step of the production system.

Feed additive solutions to support birds during challenging situations

Feed additive manufacturers are looking into accessible alternatives to mitigate the need for antibiotics in ABF systems, requiring enormous research and development efforts. At EW Nutrition, our approach is to offer a holistic antibiotic reduction program for gut health management in poultry. The program comprises feed- and water-based solutions to support gut health during high-challenge periods. Activo liquid, an in-water solution containing standardized amounts of selected phytomolecules, is a key component of our program. Based on its three-fold mode of action, Activo liquid provides gut health support that improves livability and feed efficiency:

- **Antimicrobial** activity hinders the growth of potential pathogens
- **Better gut integrity and positive microbiota** optimize feed efficiency and gut health
- **Antioxidant** activity at the gut level prevent free radical formation and oxidative stress

As a water-based solution, Activo liquid provides a quick and flexible option for gut health control on poultry farms. The benefits of Activo liquid supplementation have been demonstrated through several scientific and field studies globally.

Activo liquid reduces mortality and improves feed conversion in broilers

Numerous field studies for [antibiotic-free broilers](#) across different countries and breeds show: on average, the inclusion of Activo liquid reduces mortality by 0.6% and improves FCR by 5%, compared to non-supplemented control groups (Figure 2).

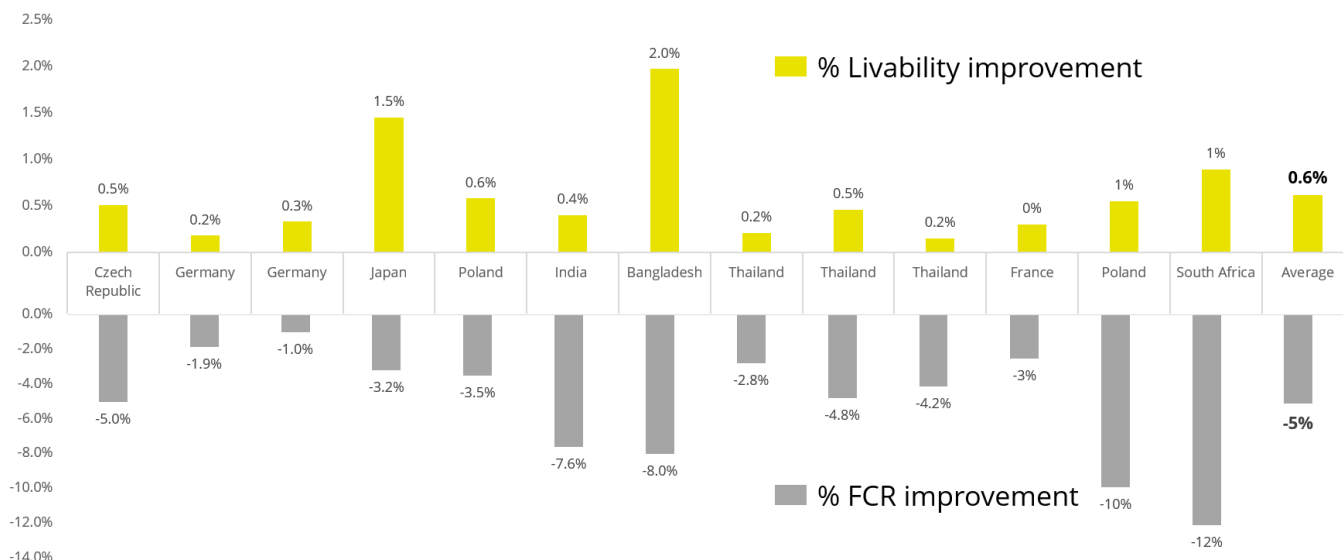


Figure 2: Changes in livability and feed conversion rate in Activo liquid-supplemented broilers

Activo Liquid supports broiler breeders from start of lay to pre-peak production

Broiler breeders are prone to gut-related issues from the start of lay to pre-peak production (age 24 to 32 weeks). This period is characterized by sudden changes in feed consumption and high production stress. Field studies from Thailand show that Activo liquid supplementation in this phase leads to improved livability and higher laying rates.

A of 34,000 female broiler breeders during the first 9 weeks of production found that for the group receiving Activo Liquid (200 ml / 1000 L, 5 days per week, 6 hours per day):

- The average laying rate/HH increased by 7.2 % during the trial period,
- Nearly 3 more hatching eggs per hen housed and about 5 more hatching eggs than the genetic standard were produced, and
- Mortality decreased by 0.2 % points compared to the control.

Another study, again evaluating the first 9 weeks of production using 20,000 birds, also found that broiler breeders supplemented with Activo Liquid show reduced mortality, a higher laying rate, and more hatching eggs per hen housed (Figure 3).

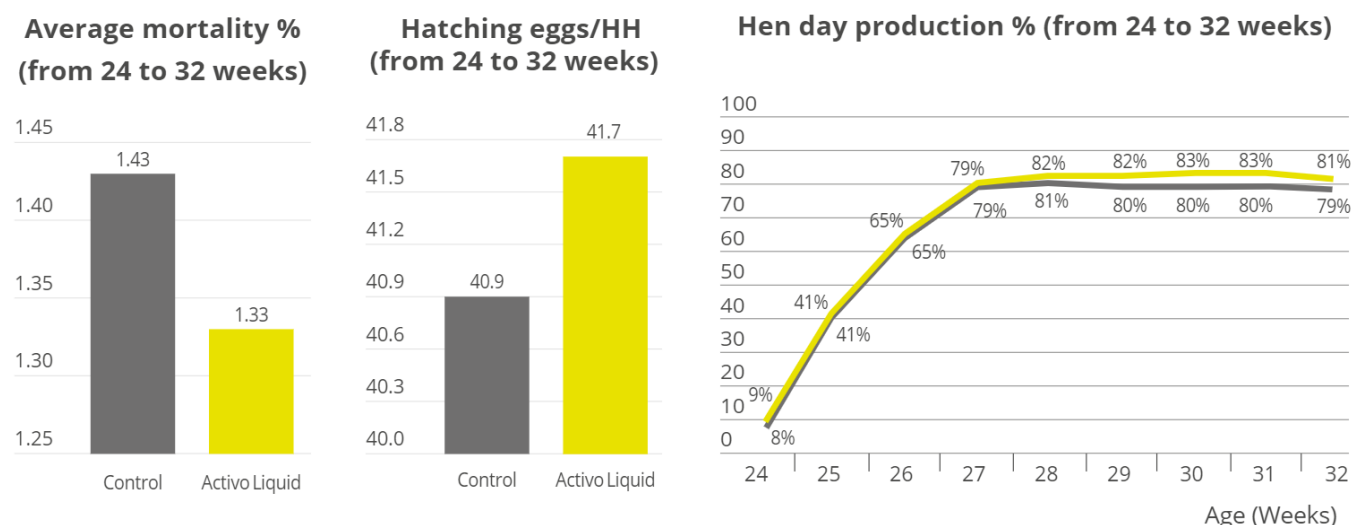


Figure 3: Performance results from Cobb broiler breeders, Activo liquid supplementation vs. control

Activo program improves layer productivity

Commercial layers often become challenged due to stress originating from management issues, gut pathogens, and an improper assimilation of nutrients. The negative impact on gut health can result in poor uniformity, low livability, and impaired body weight gain. The Activo program (a combination of Activo powder and liquid) has been found to improve layer performance, likely because its phytogenic components foster better intestinal integrity and microbiome diversity.

A study of 8 replicates with 36 Hy-line brown laying hens was conducted in China, for instance, testing the inclusion of both Activo (100 g / MT of feed) and Activo Liquid (250 ml / 1000 L for 4 days, every 2 weeks, from week 15 to week 25). It found that the Activo program can effectively support the animals in coping with NSP-rich diets (Figure 4). Supplemented layers showed 3.36% higher egg production, representing more than 3.5 eggs and more than 150 grams of additional egg mass per hen housed during the period. Better gut health in the Activo Program gut was evidenced by a better hen body weight, as well as higher yolk color, lower FCR, and improved intestinal morphology parameters.

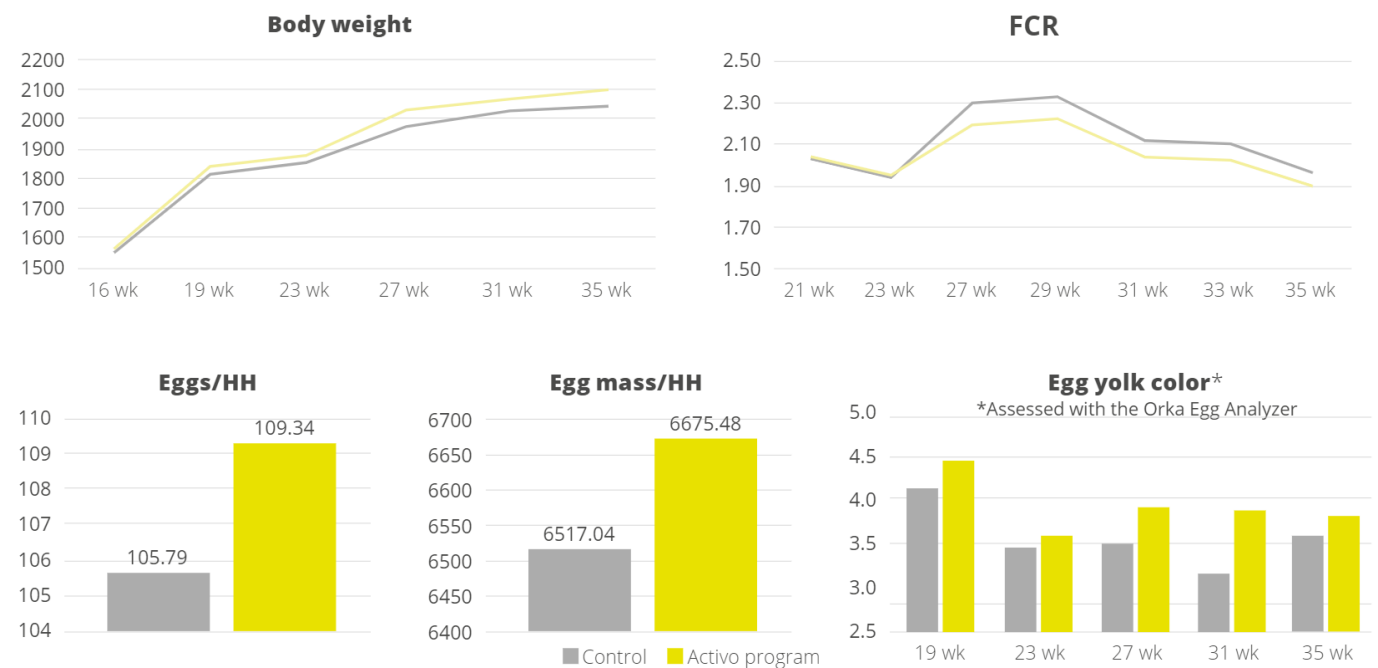


Figure 4: Performance results from Hy-line layers, Activo program vs. control

Conclusion: future improvements in poultry performance will come from the gut

As the trend towards ABF poultry production gains momentum, a concerted focus on supporting birds' gut health is key to achieving optimal performance. Multiple field studies of Activo liquid application demonstrate that, due to their antimicrobial and antioxidant properties, the phytomolecules present in Activo liquid effectively support birds' intestinal health during challenging periods.

In combination with good dietary, hygiene and management practices, phytomolecules offer a potent tool for reducing the use of antibiotics. The inclusion of Activo liquid in their birds' diets allows poultry producers to achieve better gut health and, thus, stronger performance results in a sustainable way.

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Phytomolecules: Boosting Poultry Performance without Antibiotics





Antimicrobial resistance (AMR) is a major threat to global public health. It is largely caused by the overuse of antibiotics in human medicine and agriculture. In intensive poultry production most antibiotics are used as antimicrobial growth promoters and/or used as prophylactic and metaphylactic treatments to healthy animals. Reducing such antibiotic interventions is crucial to lowering the incidence of AMR. However, antibiotic reduction often results in undesirable performance losses. Hence alternative solutions are needed to boost poultry performance. Phytomolecules have antimicrobial, digestive, anti-inflammatory and antioxidant properties, which could make them key to closing the performance gap.

Poultry performance depends on intestinal health

Poultry performance is to a large extent a function of intestinal health. The intestines process nutrients, electrolytes and water, produce mucin, secrete immunoglobulins and create a barrier against antigens and pathogens.

In addition, it is an important component of the body's immune defense system. The intestine has to identify pathogens and reject them, but also has to tolerate harmless and beneficial microorganisms. If the intestines do not function properly this can lead to food intolerance, dysbiosis, infections and diseases. All of these are detrimental to feed conversion and therefore also to animal performance.

Antibiotics reduce the number of microorganisms in the intestinal tract. From a performance point of view this has two benefits: first, the number of pathogens is reduced and therefore also the likelihood of diseases; second, bacteria are eliminated as competitors for the available nutrients. However, the overuse of antibiotics not only engenders AMR: antibiotics also eliminate probiotic bacteria, which negatively impacts the digestive tracts' microflora.

Products to boost poultry performance may be added to their feed or water. They range from pre- and probiotics to medium chain fatty acids and organic acids to plant extracts or phytomolecules. Especially the latter have the potential to substantially reduce the use of antibiotics in poultry farming.

Phytomolecules are promising tools for antibiotic reduction

Plants produce phytomolecules to fend off pathogens such as moulds, yeasts and bacteria. Their antimicrobial effect is achieved through a variety of complex mechanisms. Terpenoids and phenols, for example, disturb or destroy the pathogens' cell wall. Other phytomolecules inhibit their growth by influencing their genetic material. Studies on broilers show that certain phytomolecules reduce the adhesion of pathogens such as to the wall of the intestine. Carvacrol and thymol were found to be effective against different species of *Salmonella* and *Clostridium perfringens*.

There is even evidence that secondary plant compounds also possess antimicrobial characteristics against antibiotic resistant pathogens. In-vitro trials with cinnamon oil, for example, showed antimicrobial effects against methicillin resistant *Staphylococcus aureus*, as well as against multiresistant *E. coli*, *Klebsiella pneumoniae* and *Candida albicans*.

Importantly, there are no known cases to date of bacteria developing resistances to phytomolecules. Moreover, phytomolecules increase the production and activity of digestive enzymes, they suppress the metabolism of pro-inflammatory prostaglandins and they act as antioxidants. Their properties thus make

them a promising alternative to the non-therapeutic use of antibiotics.

Study design and results

In order to evaluate the effect of phytomolecules on poultry performance, multiple feeding studies were conducted on broilers and laying hens. They were given a phytogenic premix ([Activo®](#), EW Nutrition GmbH) that contains standardized amounts of selected phytomolecules.

To achieve thermal stability during the feed processing and a targeted release in the birds' [gastrointestinal tract](#), the product is microencapsulated. For each, the studies evaluated both the tolerance of the premix and the efficacy of different dosages.

Study I: Evaluation of the dose dependent efficacy and tolerance of Activo® for broilers

Animals: 400 broilers; age: 1-35 days of age

Feed: Basal starter and grower diets

Treatments:

- No supplement (negative control)
- 100 mg of Activo® /kg of feed
- 1.000 mg of Activo® /kg of feed
- 10.000 mg of Activo® /kg of feed

Parameters: weight gain, feed intake, feed conversion ratio, health status, and blood parameters

Results: The trial group given the diet supplemented with 100 mg/kg [Activo®](#) showed significant improvements in body weight gain during the starter period (+4%) compared to the control group. Additional significant improvements in feed conversion ratio (FCR) in the growing period (+4%) resulted in an overall improvement in FCR of 3%. At a 1.000 mg/kg supplementation, a significant improvement in FCR of 6% was observed over the entire feeding period. Hematological parameters were within the reference range of healthy birds when feeding up to 10,000 Activo®/ kg of feed.

Study II: Evaluation of the dose depending efficacy and tolerance of Activo® for laying hens

Animals: 200 hens; age: 20 to 43 weeks

Feed: basal diet for laying hens

Treatments:

- No supplement (negative control)
- 100 mg of Activo®/ kg of feed
- 250 mg of Activo®/ kg of feed
- 500 mg of Activo®/ kg of feed
- 5.000 mg of Activo®/ kg of feed

Parameters: weight gain, feed intake, feed conversion ratio, health status, and blood parameters

Results: Inclusion levels from 100 mg/kg of Activo® onwards improved laying performance, egg mass and egg weight and reduced FCR compared to the control group. Results recorded for hematological parameters were within the reference range of healthy birds when feeding up to 5.000 mg Activo®/ kg of feed.

Study III: Evaluation of the dose-dependent effects of Activo® for coccidiosis vaccinated broilers

Animals: 960 broiler chickens; age: 42 days

Feed: Standard starter and finisher feed

Treatments:

- No supplement (negative control)
- 50 g of Activo® /US ton of feed
- 100 g of Activo® /US ton of feed
- 150 g of Activo® /US ton of feed
- 200 g of Activo® /US ton of feed
- 250 g of Activo® /US ton of feed
- Antibiotic growth promoter (AGP)(positive control)

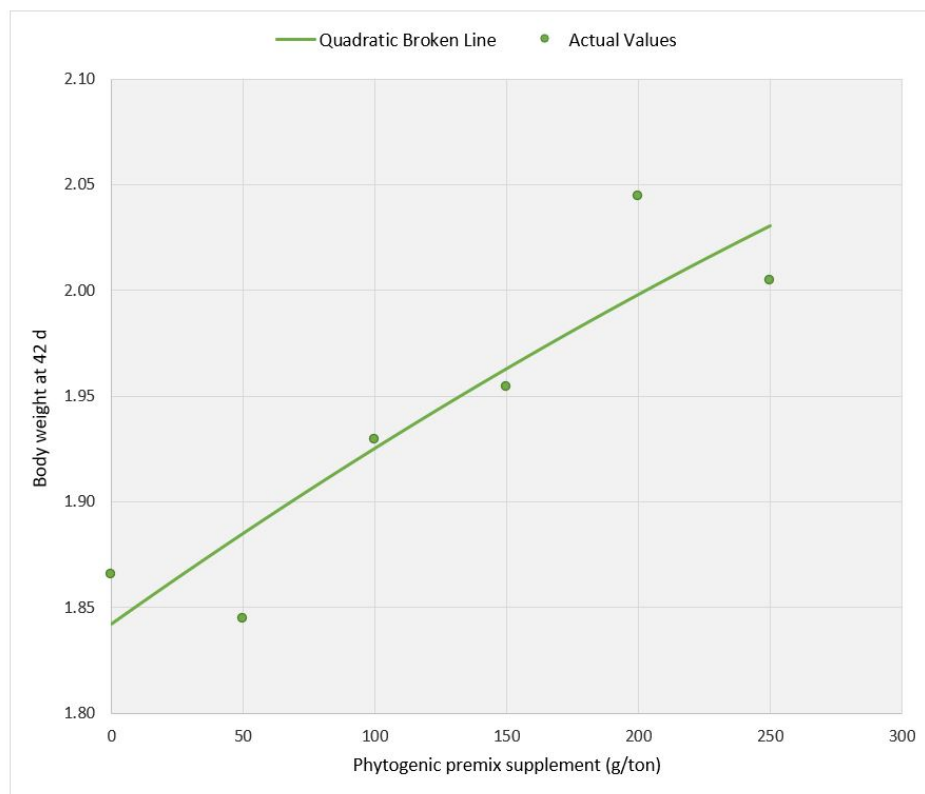
Parameters: weight gain, feed efficiency

Specific: In order to represent field conditions, the birds were challenged with used, homogenized

litter.

Results: A clear dose response for both body weight gain and feed efficiency was observed (see Figure 1): the more phytogenic premix given, the better the birds' performance. The group with 200g of Activo® /US ton of feed showed similar performance levels than the positive control group supplemented with AGP.

Figure 1: Dose-dependent effects of for coccidiosis vaccinated broilers



Study IV: Evaluation of the dose-dependent effects of Activo® for laying hens

Animals: 40 hens; age: week 20 to 43

Feed: basal diet for laying hens

Treatments:

- No supplement (negative control)
- 100 mg of Activo®/ kg of feed
- 250 mg of Activo®/ kg of feed
- 500 mg of Activo®/ kg of feed
- 5.000 mg of Activo®/ kg of feed

Parameters: weight gain, feed intake, egg production, feed conversion ratio, health status

Duration: 168 days of feeding period

Results: The laying hens showed a higher laying rate when fed with a higher concentration of phytomolecules (Figure 2). Similarly improved results were observed for the feed efficiency. The more phytogenic premix added to their diet the better feed efficiency (Figure 3).

Figure 2: Dose-dependent effects of Activo© on laying rate in laying hens

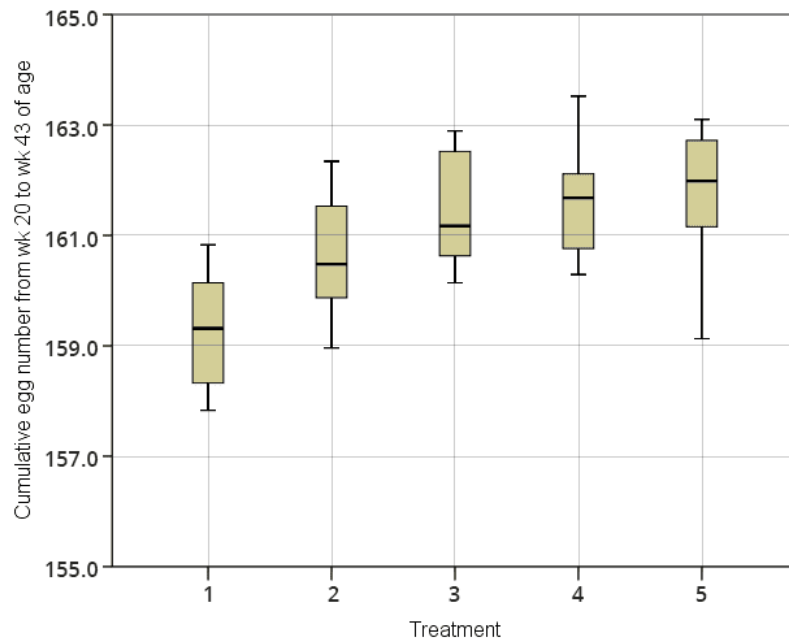
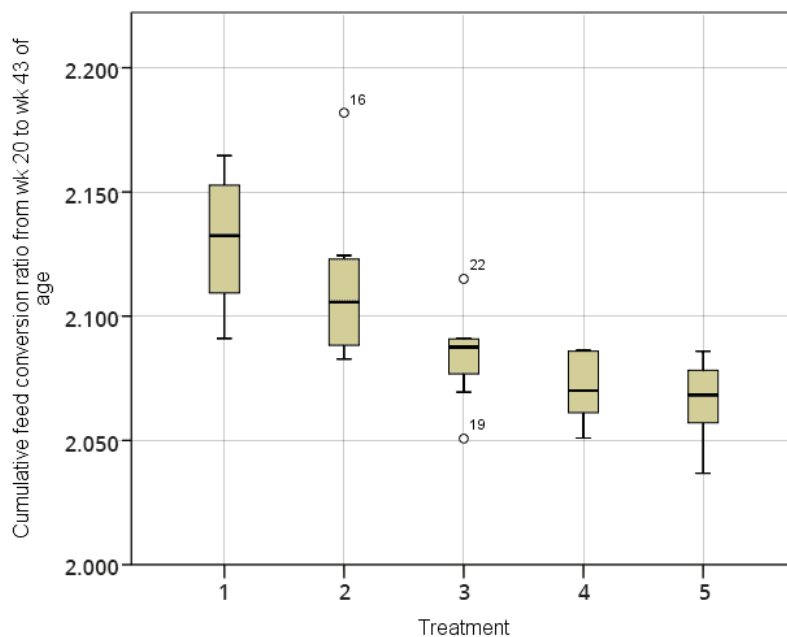


Figure 3: Dose-dependent effects of Activo© on feed efficiency in laying hens



In conclusion, all four studies indicate that the inclusion of phytochemicals in broilers' and laying hens' diet improves their performance. Increasing levels of a phytochemical premix (Activo®) significantly increased the production parameters for both groups. These improvements might bring performance in antibiotic-free [poultry production](#) on par with previous performance figures achieved with antimicrobial growth promoters.

The studies also showed that microencapsulated phytochemical premixes are safe when used in dose ranges recommended by the suppliers. No negative effects on animal health could be observed even at a 100 fold / 50 fold of the recommended inclusion rate in diets for broiler or laying hens, respectively. Thanks to their positive influence on intestinal health, phytochemicals thus boost poultry performance in a safe and effective way.

By Technical Team, EW Nutrition

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