Broiler production with reduced antibiotics. The essentials

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Concerns about antibiotic resistance in humans and production animals have prompted a push across the board to reduce antibiotic use, including in livestock rearing. To meet these demands, the industry must keep the pathogenic pressure in production units as low as possible, enabling production with no antibiotics or minimum use of antibiotics.

The 3 essential steps for reducing antibiotics in broiler production

In the following, we discuss experience-based insights and practical advice concerning best practices for broiler meat production with reduced antibiotic use, focusing on the following points:

Farm biosecurity
Management of the broiler house, including cleaning & disinfection, and environment & litter management
Management of the flock, including DOC quality, disease prevention, and nutrition

1. General farm biosecurity

Biosecurity is the foundation for all disease prevention programs (Dewulf et al., 2018). Thus, it is essential in antibiotic reduction scenarios. It includes all measures taken to reduce the risk of introducing and spreading diseases, preventing diseases, and protecting against infectious agents. Its fundament is the knowledge of disease transmission processes.

The application of consistently high biosecurity standards substantially reduces antimicrobial resistance by preventing the introduction of resistance genes into the farm and lowering the need to use antimicrobials (Davies & DWales, 2019).

First of all: everyone must act in concert!

Biosecurity is one of the preconditions for the success of an ABR program, and it is crucial to bring all workers/staff on track through regular training on the best practices and their subsequent rigorous implementation. The biosecurity plan can only be effective if everyone on the operation follows it – all the time. Farm managers, poultry workers, and other persons entering the facility should adhere to the farm biosecurity measures, 24/24h – 7/7d.

Separation helps to prevent the spread of pathogens

One essential component for biosecurity is implementing a “line of separation” for the farm and each house. It is vital to have a good separation between high and low-risk animals and between areas on the farm that are dirty (general traffic) and clean (internal movements). In this way, it is not only possible to avoid the entrance but also the spread of disease, as potential sources of infection (e.g., wild birds) cannot reach the farm population.

The farm must be well isolated, not allowing the entry or passage of persons who do not work there and animals, including pets.

Inside the farm, the walls of the poultry house form the first line of separation, and the “Two-zone Danish Entry Protocol” constitutes a second line. This system utilizes a bench to divide the anteroom of a poultry house into two sides (outdoor / ‘dirty area’ and indoor / ‘clean area’). At a minimum, footwear should be changed, and hands washed or disinfected when passing over the bench; it is even better when workers have house-specific clothing and hairnets when entering the poultry area.

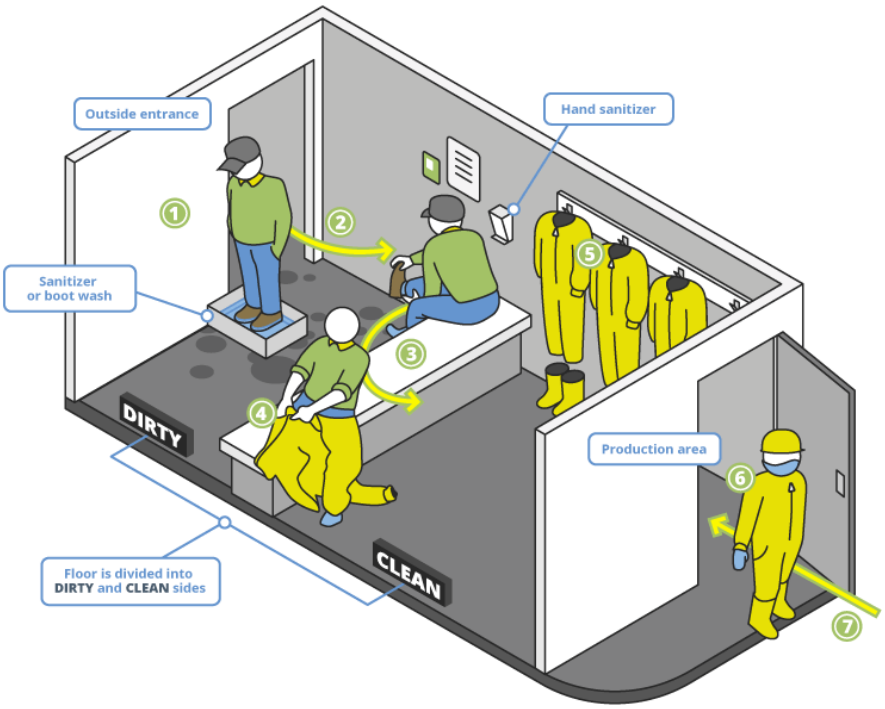

Figure 1: Safety procedures on the poultry farm – the Danish entry method

The room is divided into “dirty” and “clean” zones.

1. After the entrance from outside, workers/visitors step into a disinfectant boot tray.
2. They take off their street shoes and leave them on the dirty side of the entrance zone.
3. Then, they turn from the dirty to the clean side by swinging their legs without touching the floor.
4. They wash their hands and disinfect them by using the hand.
5. They must put on an overall, cap, mask, and boots of the poultry house.
6. Completely clothed, they can enter the poultry house.
7. When they leave the house, a reversed process must be followed.

Still more needs to be done to prevent the entrance and spread of disease.

Separate materials for each house

For each house, separate materials must be used, keeping a dedicated set of tools and equipment necessary for daily work.

Very important: no materials should be moved from one house to another unless thoroughly disinfected. Crates for bird transport in the case of thinning (partial depopulation of a broiler flock) are an important example.

Practice clean disposal of mortality

First, dead birds’ removal must be frequent (minimum twice a day) as carcasses are a source of infection. The next point is to make sure the route of birds’ disposal is strictly unidirectional, and the buckets or wheelbarrows for the transport of the dead birds do not reenter the poultry house. Finally, the carcasses should remain outside the farm or as far from the buildings as possible until collection, incineration, or composting.

2. Broiler house management

After the general organization on the farm, let’s move on to the poultry houses.

Cleaning and disinfection of the house are the first steps – and check their efficacy!

Cleaning and disinfection are essential components in preventing the persistence and spread of pathogens. Both together aim to decrease microbial numbers on surfaces (and in the air) to a level that will ensure that most -if not all- pathogens and zoonotic agents are eliminated.

Cleaning refers to the physical removal of organic matter and biofilms, so the microorganisms and pathogens are afterward exposed to the disinfectant.

For effective cleaning and disinfection, the all-out/all-in system has proven of value. When birds are collected, all organic material, including feed residues and litter/feces, is removed.

Effective detergents and hot water are used to remove any grease or organic material. Pay special attention to the floors! Also, all surfaces and equipment should be sufficiently cleaned and given final disinfection.

Cleaning is crucial

A study by Luyckx and collaborators (2015) revealed that the mean total aerobic bacterial count on swab samples taken in broiler houses decreases significantly already after cleaning (figure 2). Good cleaning not only strongly reduces microbiological contamination and organic material but also ensures that the subsequent disinfection has a stronger impact on the remaining microorganisms. Consider that all disinfectants, even in high concentrations, are barely effective in the presence of organic material.

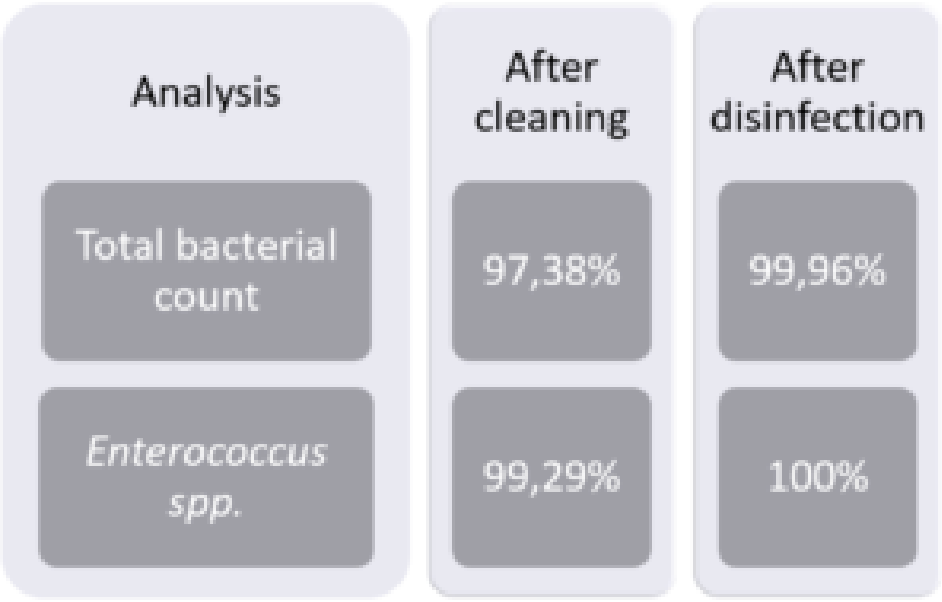

Figure 2: % of reduction of bacteria on surfaces after cleaning and after cleaning and disinfection (adapted from Luyckx et al., 2015)

Keep an eye on cleaning & disinfection efficacy

After cleaning and disinfection are complete, it is good practice to check the floors for Total Viable Count (TVC), Salmonella, and *E. coli* to test the efficacy of the cleaning and disinfection process. Recommended

levels of TVC should be less than ten colony forming units per square centimeter (CFU/cm^2), and *E. coli* and Salmonella levels should be undetectable.

When high TVC are found, the cleaning and disinfection procedure must be evaluated, including the products (a rotation is recommended) and their application (e.g., dosage, dilution, water temperature, and exposure time). Also, possible reinfection by vermin or personnel during the downtime must be controlled.

Downtime:
After cleaning and disinfection, a down-time time of 10 days allows disease-causing pathogens to die (UC Davis, 2019).

Cleaning and disinfection of the waterline against biofilm

In the waterlines, the build-up of biofilms can be an issue. Biofilm is a sticky film that can be found inside water lines, regulators, and nipple drinkers. It starts when bacteria attach to a surface and produce a matrix of extracellular polymeric substances (EPS), including proteins and sugars, giving the biofilm the stickiness that traps other bacteria and organic matter. It provides the bacteria with protection from the external environment, and thus they multiply and thrive.

Biofilms not only block the water flow, but they can also include pathogenic bacteria. Thus, the waterline must be regularly cleaned and disinfected, not only between flocks but also within each flock.

Between flocks, an effective waterline cleaning should include:

- Application of hydrogen peroxide at high concentration, leaving it in the system for 24-48 hours to remove the biofilm from the pipelines)
- Flush the line to remove the detached biofilm, also activate the nipples with a broom or stick to flush them
- Immediately before the placement of the new chicks, the water lines should be flushed to have fresh drinking water available to the chicks
- The water pressure must be adjusted so that a droplet of water is visible at the end of each nipple, and the drinkers are put to the correct height to stimulate water intake and avoid spilling

During the life of the birds, a water disinfectant should be used to prevent biofilm formation, e.g., hydrogen peroxide in weekly applications or the continuous use of chlorine. Also, flushing is a good practice during the whole cycle to make sure that biofilm is removed and the birds count with fresh drinking water.

To a certain extent, biofilm build-up can be prevented by using organic acidifiers in the water, which improves the sanitizers' effectiveness and reduces bacterial growth in water lines.

Correct ventilation helps to prevent respiratory diseases

To keep broilers healthy, providing optimal ventilation in the poultry house is crucial. CO_2 and temperature are the most critical parameters. CO_2 should never exceed 2500 ppm and should be monitored continuously, most notably in the early morning before birds increase activity (e.g., eating). Ventilation rates should be adjusted to keep CO_2 below this limit. Draught or cold spots resulting in uneven distribution of birds in the house should be avoided, and causes should be investigated and repaired immediately.

Incorrect ventilation often is the reason for respiratory diseases and the need for antibiotic treatment. No matter if natural or power ventilation is used, proper monitoring of the system is indispensable to ensure the well-functioning of the equipment and, therefore, appropriate air quality (Neetzon et al., 2017).

Litter management to keep diseases in check

Effective litter management is another step on the road to keeping the birds healthy. Dryness of litter and ammonia level at bird's level are two significant key success factors in raising broilers. Dry litter preserves the footpads, so litter material should have a good moisture-absorbing capacity (e.g., chopped straw, wood shaving, rice husks, sunflower husks). When using build-up litter, litter sanitation and treatments need more attention.

Litter treatment (with acidifying or binding substances) and adequate ventilation are the most practical measures to control ammonia and improve littler quality (Malone, 2005). Keep litter temperature at 28 – 30°C (82.4 – 86°F), and use only litter tested or certified to have a TVC <10 CFU/g.

3. Flock management

The basis: healthy, high-quality day-old chicks

To produce good-quality day-old chicks, the parent flocks (PS) must be of good health status. PS should be free from vertically transmitted diseases such as Mycoplasma and Salmonella and be vaccinated/protected against important diseases:

> *Salmonella pullorum/Salmonella Gallinari* should be assessed in PS by RPA serology in week 25-30, at least 60 samples per flock.
> *Mycoplasma gallisepticum* should be checked by RPA/ELISA serology on a regular basis, preferably at least monthly, with a minimum of 30 samples per flock.

Parent flock vaccination leads to the production of maternal antibodies that help prevent horizontal infection (from the broiler farm environment) in chicks at an early age. This type of prevention is the primary function of some vaccinations, such as against Gumboro disease.

An essential part of the broilers' life occurs already in the hatchery. Single-stage incubation is recommended, and all floor eggs and dirty nest eggs should be excluded to assure the best day-old chick quality.

Comfortable conditions bring chicks to eat

The brooding phase needs special attention; it is about welcoming the chicks and making them comfortable in the house environment. For this, enough litter needs to be provided, the environment must be managed, and feed and water must be supplied.

At least 24 hours before chick placement, the house and floor temperature are increased to a minimum of 34°C and 28°C, respectively. Proper ventilation and lighting are also essential. These conditions need to be monitored and adjusted after the placement so the chicks feel comfortable and start feed and water consumption. Checking chick behavior is crucial during the first hours after placement.

Upon the placement of the chicks, it is recommended to have pre-starter crumble feed available on top of brooder paper underneath the drinking line. To stimulate early feed and water consumption, gently place the chicks onto that paper. The target is to have 100 % of chicks with crop filled within 48 hours of chick placement.

Reduce the stocking density

In general, high stocking density may restrict bird movement, interfere with airflow, and increase litter moisture and microbial growth, including pathogens, which potentially impairs broiler health, welfare, and performance.

When reducing antibiotics, increase the space per bird by 0.05 ft^2/46 cm^2 per bird compared to your current conventional program. A lower stocking density helps keep litter moisture at a minimum, which reduces the shedding of cocci oocyst and pathogenic bacteria over the population.

Feed and water access must be granted to all animals at every moment. The number of chickens per feeder or drinker depends on the type of equipment used.

Consistent observation of the flock

To recognize emerging health issues, producers should critically observe the behavior of birds every day. On which points should they focus?

> First, when entering the house, birds' behavior and response to the poultry worker should be observed with attention. Note the spread of birds throughout the house.
> Note birds' drinking and eating behavior. Feed and water intake should be recorded daily, always at the same hour.
> The quality of the fresh fecal droppings should be judged. Any changes in the fecal droppings (loss of consistency) can help notice emerging disease and take measures against it.

Especially during and after feed change, attention to changes in the usual feces consistency is necessary.

Vaccination and judicious antibiotic use are crucial

Carefully consider vaccination programs for broilers. Unnecessary vaccinations impact the immune system, possibly resulting in reduced performance and, in some circumstances, make the birds more susceptible to other diseases. Hence, the vaccination program must be diligently attuned (Neetzon et al.,

2017).

- The disease background of the parent farm as well as the broiler farm where the chicks will be placed are essential factors for the vaccination program
- If possible, vaccine strains that are the least immunosuppressive should be chosen
- If coccidiostats are not permitted, an effective vaccination against coccidiosis is required and must be done as early as possible
- All vaccinations must be given using a standard operating procedure that minimizes bird discomfort and optimizes the vaccine, and always administer vaccines following the advice from the manufacturer

After the vaccination, it is essential to monitor the effects of vaccination stress and take preventive measures to avoid any issues with broiler performance in terms of weight gain and mortality.

Use antibiotics with discernment

As we aim to reduce antibiotics, they should be limited to pure therapeutic use, only if other disease-prevention measures have not been successful, and mortality or disease symptoms make the treatment necessary. Before the treatment, the disease must be diagnosed by a qualified veterinarian. The diagnosis should be preferably followed up by isolation of the disease-causing bacteria, classification, and susceptibility testing before the antibiotics are applied.

Small-spectrum antibiotics that are less likely to cause antimicrobial resistance (AMR) should be preferred. Broad-spectrum antibiotics or antibiotics that are likely to cause AMR can only be used after susceptibility testing has demonstrated resistance to a first-choice antibiotic. The treatment effect must be evaluated by daily monitoring of disease symptoms, mortality, water, feed intake, and body weight gain.

Thinning – things to consider

If thinning (partial depopulation) is practiced, it should be done with the highest bio-security measures. Producers must ensure that the equipment used in the catching process is thoroughly cleaned before entering the house, and bird-catching personnel takes the same measures as farm personnel when entering the farm and the house. These policies will help to minimize the introduction of infectious agents.

Keep the feed withdrawal period for this process as short as possible to avoid flightiness, which can induce skin lesions (some regions catch birds in low light intensities to avoid flightiness). A short feed withdrawal period also prevents over-consumption of feed in a short amount of time, possibly disrupting feed passage in the gut and leading to bacterial imbalance and dysbacteriosis in the remaining birds. After thinning, feed and temperature must be adapted to the lower number of animals.

Provide your birds with high-quality water for drinking

Water is the most important nutrient for broilers. It plays an essential role in digestion and metabolism, thermoregulation, and waste elimination.

Several factors affect water quality: temperature, pH, bacteria, hardness, minerals, and total dissolved solids. These parameters should be analyzed at least twice per year. If necessary, corrective actions should be taken, e.g., a filtration to remove minerals, the addition of chlorine for disinfection, or the addition of organic acids to drop the pH.

Before each cycle, the water must be tested for total aerobic + enterobacteria, compared to reference values: Total plate count (TPC) should be < 1000 CFU/ml, and *E.coli*, Enterobacteriaceae, yeast, and molds at undetectable levels. The section about cleaning and disinfection of the waterline provides insights and practical advice about water sanitation and microbiological analysis.

Nutrition & feeding – a pillar for antibiotic reduction

Nutrition and feeding in ABR broiler production are not only about providing nutrients for growth but also about the effects of the feed on gut health. Gut health is essential for animals' overall health, welfare, and productivity, even more so in antibiotic reduction scenarios.

Feed should be of the highest quality – in all respects

High feed quality is necessary to provide the animal with the required nutrients and achieve their optimal utilization. Also important is the absence, limitation, or management of harmful substances and pathogens. High quality, therefore, includes:

Form and composition of the final feed
Nutritional value of the raw materials
Management of harmful substances.

From reception and storage of the raw materials to the dispatch of the finished feed, the feed mill management emphasizes their quality assurance system, which is decisive in this connection.

First measure: quality assurance at the feed mill level

The feed mills producing for operations with no or reduced use of antibiotics must have a quality assurance (QA) and/or a good manufacturing program (GMP) in place that guarantees the production of consistently good quality feeds.

Proper raw material management and processing of feeds are necessary to achieve the lowest possible microbial-pathogen load, including:

An effective rodent and wild birds control
Disinfection of all the vehicles entering the feed mill
Proper storage and utilization of raw materials (e.g., first in-first out use, silo management)
Periodic thorough cleaning of milling equipment, premises and storage areas, and the monitoring of these activities
Standard operating procedure and quality assurance systems that guarantee feed safety and quality

Check the quality of the raw materials and the final feed

Digestion, absorption, and gut health depend on the quality of the feed ingredients. To provide the best preconditions for healthy growth, producers should avoid raw materials of a reduced and/or inconsistent quality. For this purpose, each raw material batch should be analyzed for its specific quality parameters. Quality parameters to consider are:

Physical ones, such as color, odor, particle size, and general appearance
Chemical ones, such as nutritional composition and specific parameters. For example, grains should be analyzed for mycotoxins and antinutritional factors; fats and oils need to be analyzed for free fatty acids (FFA), unsaturated/saturated (US) ratio, iodine value (IV), but also the peroxide value (PV) as oxidized fats have a lower energy value, and their intake is related to enteric diseases
Biological ones, including yeasts, molds, and enterobacteria

Also, the finished feed should be monitored by analyzing every batch concerning composition compared to values in the feed formulation, as well as physical, chemical, and microbiological quality parameters.

Clean storage on the farm prevents feed spoilage

As in the feed mill, keeping the farm facilities clean is of the highest importance. Warehouses, silos, bins, feeders, etc., should be emptied, cleaned, and disinfected after each flock; this avoids the formation of feed aggregates that can lead to mold growth and mycotoxin contamination; also, insects, bacteria, and parasites can remain in those residues.

Adapt feed formulation and feeding to the feeding phase

The value of phase feeding

Having the correct number of dietary phases to meet animal demands and avoid excess nutrients provides better intestinal health and thus aids production animals in ABR scenarios. The feeding phases should be designed to prevent abrupt changes in nutrition and raw material inclusions, possibly leading to dysbacteriosis.

Feeding for gut health

When feeding broilers in antibiotic reduction scenarios, extra care should be taken when formulating diets. The challenge is to achieve the same performance as conventional management at an optimum cost.

Don’t waste nutrients: Improve feed digestibility, and at the same time, reduce the dangers of antinutritional factors coming from different ingredients by using suitable exogenous enzymes.
Keep an eye on fiber: Moderate levels of insoluble fibers with adequate structure and composition can be included to promote gizzard development and function. This measure leads to a better modulation of gut motility and feeds passage into the intestine. Additionally, it promotes gut health, resulting in higher nutrient digestibility.
Be careful with protein: Excess of undigested protein in the hindgut may lead to the proliferation of *Clostridium perfringens*; then, subclinical challenges of necrotic enteritis may occur. Moreover, the excess of nitrogen may increase feces moisture content, leading to wet litter. The optimization of the diets based on digestible amino-acid profiles and the use of synthetic amino acids decrease or eliminate the minimum requirements of crude protein, avoiding its excess.

Which feed form?

The feed form depends on the age or feeding phase: starter feeds can be offered as coarse mash, but preferably as crumble or mini-pellets (< 2 mm diameter) and grower and finisher diets as 3 – 4 mm pellets.

When using pelleted diets, quality is also the most crucial criterion. Poor pellet quality and thus the excess of fine particles increase feed passage rate, resulting in poor gizzard development and compromised gut health.

A high-quality pelleted feed can withstand – without much breakage – the handling that occurs after processing, such as transportation, storage, and farm management. Pellet quality can be measured by the Pellet Durability Index (PDI) obtained by simulating the impact and shear forces in a known quantity of feed for a determined amount of time. After this time, the sample is sieved, and the fines are separated, weighed, and compared with the initial sample

The PDI should be measured in the feed mill and compared to a standard. Later, it is also recommended to measure the PDI on the farm, and the producer should take corrective actions if the pellets cannot maintain their quality.

Additionally, it should be known that coarse ground grains stimulate gizzard development and function. So, about 30 % of the feed should consist of particles between 1-1.5mm (post pelleting) in all feeding phases.

Broilers’ selection criteria for feed are form, color, size, and consistency

Broilers’ selection criteria for feed are form, color, size, and consistency. They prefer feed that is easy to pick, such as crumbles or pellets.

Feed additives can support antibiotic reduction

The feed additive industry provides broiler farms and integrations with various solutions to make production more manageable and efficient.

A healthy start is half the battle

Let’s start with the chicks. The early introduction of beneficial bacteria into the intestinal tract has proven helpful for gut health optimization. This colonization can be achieved with the administration of suitable probiotics preparation at the hatchery. Multi-strain probiotic preparations effectively initiate healthy microbiome development for optimum gut health. For these challenges, support is offered through EW Nutrition’s VENTAR D and ACTIVO LIQUID, phytomolecule-based products for the feed and the waterline, respectively.

Maintain gut health

Gut health is one of the essential preconditions for efficient growth. Only a healthy gut guarantees efficient digestion and absorption of nutrients. Several approaches are recommended to maintain gut health:

> Promotion of beneficial and reduction of pathogenic gut flora: here, solutions can come in the shape of products based on phytomolecules that can be applied with the feed (VENTAR D) or the water (ACTIVO LIQUID)
> Management of bacterial toxins and mycotoxins: for this topic, products mitigating the toxins’ negative impact on the birds (Product range of MASTERSORB and SOLIS) are offered

Protect your feed

When feed is stored, there is always the risk of bacteria, mold, or yeast overgrowth. Oxidation of feed ingredients, such as fats and oils, reduces their nutritional value. These issues can be prevented by applying:

- Acidifiers that have antimicrobial effects due to their pH-decreasing effect, which, later on, improves the feed digestibility and stabilizes the GIT flora (ACIDOMIX, FORMYCINE, and PRO-STABIL)
- Antioxidants preserving ingredients susceptible to oxidation, such as fats and oils (AGRADO, SANTOQUIN, and STABILON)

Improve pellet quality

Moisture retention during the conditioning process influences pellet quality: higher moisture retention entails a higher starch gelatinization resulting in higher digestibility, pellet binding, fewer fines, and a higher PDI. Surfactants (for example, SURF•ACE) are compounds that can reduce the surface tension between the water and the feed, improving moisture absorption during the conditioning process.

Besides that, moist steam in the pelleting process penetrates better and has a higher antimicrobial effect leading to lower production of bacterial and mycotoxins. The possible reduction of the pelleting temperature protects the nutrients.

ABR in broiler production is practicable – by observing some rules

As shown above, antibiotic-reduced broiler production needs many aspects to be considered and a lot of measures to be taken. All of these measures seek to keep animals healthy and avoid antibiotic use. Maintaining gut health is crucial, as only a healthy gut performs well, achieves the optimal utilization of nutrients, and increases growth performance.

Maintaining a successful production unit with no or reduced antibiotic use requires a holistic approach in which best practices must be assured at all levels of the production chain. The feed additive industry provides a broad range of solutions to support animal production through this challenging task. The objective could not be more critical: lowering antibiotic resistance to assure the future of animal and human health.

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Phytogenic additives: An ROI calculation

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Global trade in agricultural products has a direct impact on the added value in regional broiler production. Due to fluctuating meat and feed prices, a tight profit margin can melt away quickly. Changes such as the use of cheaper raw materials, implemented to deal with reduced margins, may negatively affect flock health, creating a vicious cycle: If the flock also experiences increased disease pressure, the financially critical situation worsens.

What can the right phytogenic feed additive deliver for broiler producers?

It is essential to improve broiler gut health, as only healthy birds will perform and allow producers to be profitable. Producers can maintain flock performance through preventive management measures, a consistent hygiene concept, and the use of high-quality feed. For unproblematic flocks, the same measures also positively affect profit, generating a healthy return on investment (ROI).

What affects your return on investment?

In broiler production, the cost of feed is highest, with a share of 60 – 70 % of the total production costs. The proportion tends to be higher in markets that rely on importing feed raw materials (Tandoğan and Çiçek, 2016).

Let us take an example: With a compound feed price of 300 € / t as the basis, an increase of 10 € / t results in a profit reduction of 0.016 € / kg live weight. On the other hand, an improvement in feed conversion from 1.60 to 1.55 results in a financial advantage of 0.015 € / kg live weight. The best possible feed efficiency is always desirable to keep production costs low.

Another risk factor for high-yield broiler production lives in the poultry intestines: the most significant “invisible” losses result from subclinical necrotic enteritis (*Clostridium perfringens*). This disease worsens

the feed conversion on average by 11 % (Skinner et al., 2010). In the previous example, this would reduce feed efficiency from 1.60 to 1.78 points and reduce the contribution margin by 0.054 € / kg live weight. In addition, a live weight reduction of up to 12 % can be observed (Skinner et al., 2010). It is, therefore, critical to stabilizing gut health to reduce the risk of subclinical necrotic enteritis.

Practice prevention for a secure return on investment

The prophylactic use of antibiotics in compound feed was a well-known reality for decades. With the EU-wide ban on the use of antibiotic growth promoters, the occurrence of multi-resistant bacteria, and a globally increased demand for antibiotic-free chickens, producers now have had to cut down on antibiotic use.

For this reason, a lot of research has been conducted into alternative measures for maintaining good broiler health. Studies have confirmed that setting up a comprehensive hygiene concept to reduce the formation of biofilms on stable surfaces and reduce the recirculation of pathogens is a solid basis. At every production stage, irregularities can be detected through a meticulous control of performance parameters and illness symptom-centered health monitoring. Diseases can either be avoided or at least recognized earlier through targeted measures, and treatment can be carried out more efficiently.

A thorough hygiene concept and careful monitoring at every production stage are key to ensuring broiler performance.

Feed additives for intestinal stabilization

Hygienically impeccable compound feed is the wish of every animal producer to promote the development of a balanced intestinal flora. However, the quality of the available raw materials is subject to fluctuations and can therefore not be 100 % anticipated. Consequently, producers are now commonly balancing these uncertainties by using feed additives, which positively influence the intestinal flora. These products must prove their positive effects in scientific studies before they can be used in practice.

An effective solution: Encapsulated phytogenic feed additives

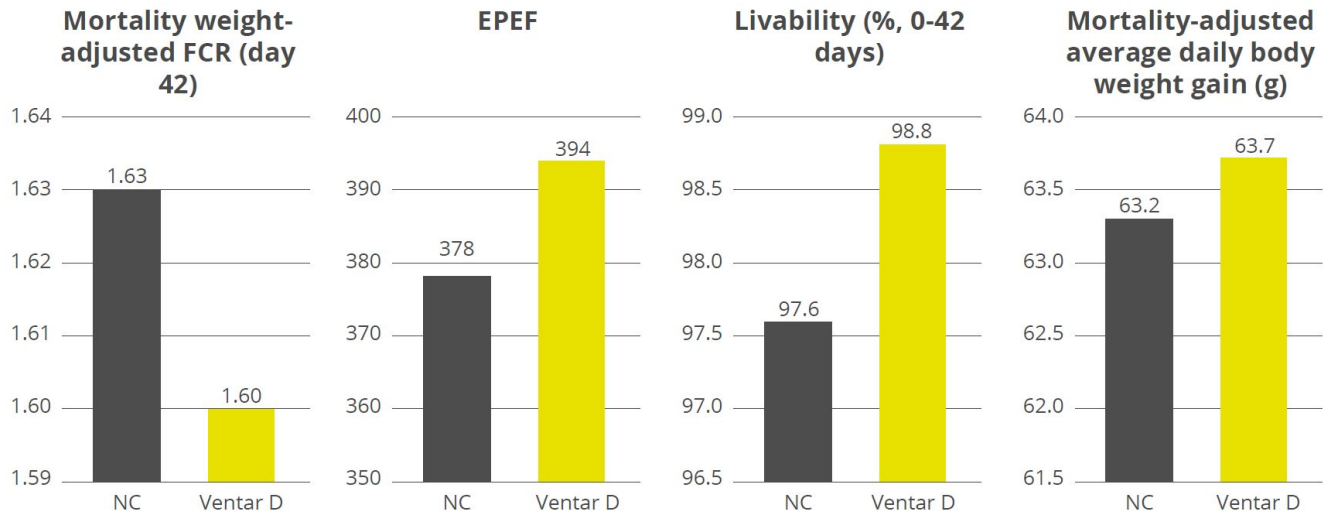
Studies have found that certain phytomolecules, which are secondary plant metabolites, can support broiler gut health. By stimulating digestive enzyme activities and stabilizing the gut microflora, feed utilization improves, and broilers are less prone to developing enteric disorders (Zhai et al., 2018).

The encapsulation of these naturally volatile substances in a high-performance delivery system is critical for the success of a phytogenic feed additive. This protective cover, which is often a simple coating, provides good storage stability in many cases. However, in addition to the high temperatures, mechanical forces also act on these coatings during pelleting. The combination of pressure and temperature can break the protective coating of the product and lead to the loss of active substances.

A complete solution: How Ventar D maximizes your ROI

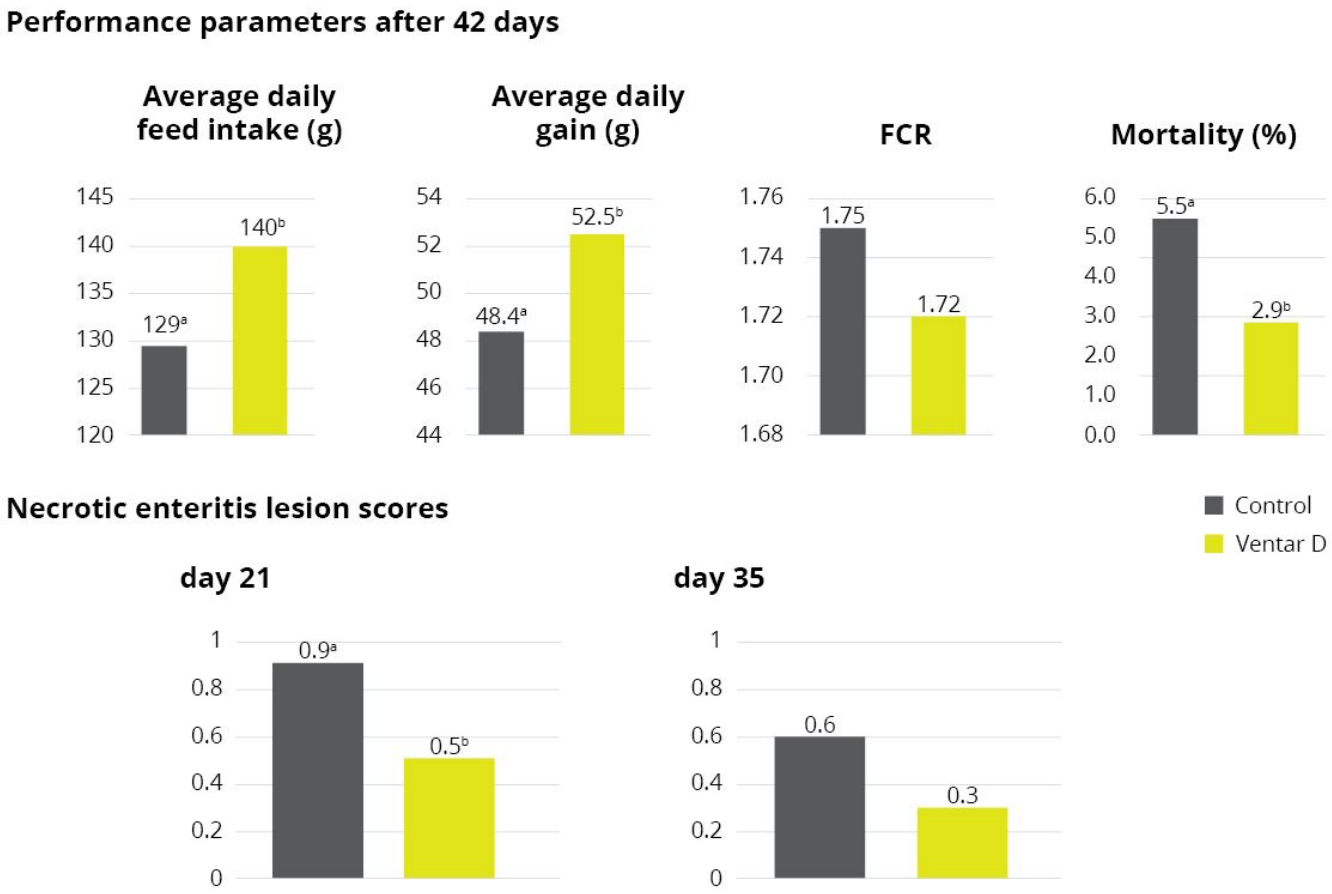
Because of the difficulties mentioned, the use of modern delivery system technologies is therefore necessary. EW Nutrition has many years of experience in the development of phytogenic products. Due to an original, innovative delivery system technology, Ventar D can offer high pelleting stability for optimal improvement of animal performance.

In particular, the positive influence of the phytogenic feed additive Ventar D on intestinal health under increased infection pressure was assessed in multiple studies. In two studies carried out in the United Kingdom, birds were challenged by being housed on used litter harvested from a previous trial. Moreover, increasing levels of rye were introduced into the diet, adding a nutritional challenge to provoke an increased risk of intestinal infections in the broilers. The use of 75 g of Ventar D per t compound feed increased the EPEF (European Production Efficiency Factor) by 4.1% and feed efficiency from 1.63 to 1.60.



With Ventar D use at 100 g / t compound feed under comparable conditions, EPEF increased by 8.9 %, and feed efficiency improved by 5 points (0.05), compared to a non-supplemented control group (NC).

Another study was carried out in the USA. In addition to performance parameters, data on intestinal health were also recorded. In the group fed with Ventar D (100 g / t compound feed), 50 % fewer necrotic enteritis-related lesions of the intestinal wall were found after 42 days. Compared to the group fed with Ventar D, the broilers of the control group showed a performance decrease of 11.8 % with an 8% lower final fattening weight and a 3 points poorer FCR.



Based on the results of the above studies, the ROI for Ventar D due to the improvement in feed efficiency by 3 and 5 points could be 1:3.5 and 1:6.5, respectively. Similarly, the net returns for using Ventar D could be 0.007 and 0.013 € / kg live weight, given the 3 and 5 points improvements in feed efficiency. The ROI for Ventar D use could be even higher thanks to additional benefits such as improvements in litter condition and foot pad lesions, reduced veterinary cost, etc., depending on the prevailing challenges.

The future of feeding is here

The first study results for Ventar D underscore that, if combined and delivered right, phytomolecules can transform broiler performance from inside the gut. Ventar D's stable delivery system ensures a constant amount of active molecules in targeted intestinal sites and, therefore, supports a favorable intestinal flora. With Ventar D supplementation, subclinical intestinal infections due to *C. perfringens* or other enteric bacteria can be very well kept in check, ensuring improved broiler productivity and production profitability.

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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 defenses 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 antibiotics 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

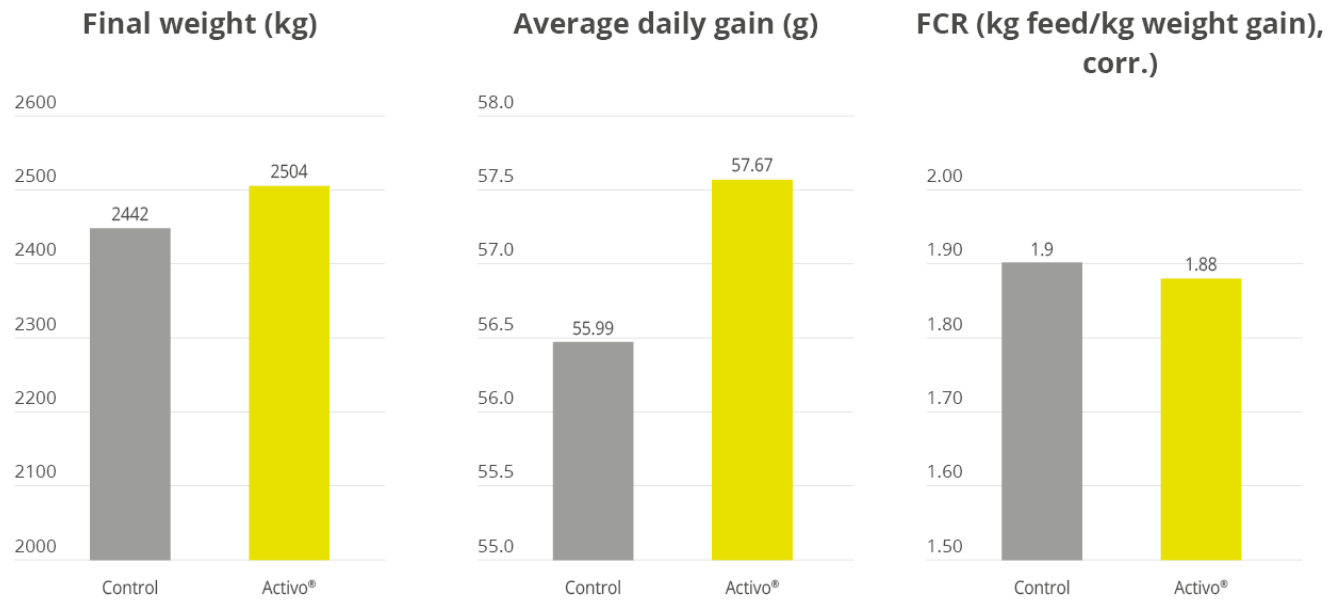

Figure 1: Broiler performance results, Activo vs. non-supplemented control group

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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Challenging times for broilers? Phytomolecules, not antibiotics, are the answer

*by **Ajay Bhoyar**, Global Technical Manager, EW Nutrition*

Anyone working with today's fast-growing broiler chicken knows that it is a sensitive creature – and so is its gut health. Thanks to continuous improvements in terms of genetics and breeding, nutrition and feeding, as well as general management strategies, broiler production has tremendously upped performance and efficiency over the past decades. It is estimated that, between 1957 and 2005, the

broiler growth rate increased by over 400%, while the feed conversion ratio dropped by 50%.

These impressive improvements, however, have come at the cost of intense pressure on the birds' digestive system, which needs to process large quantities of feed in little time. To achieve optimal growth, a broiler's gastrointestinal tract (GIT) needs to be in perfect health, all the time. Unsurprisingly, enteric diseases such as necrotic enteritis, which severely damages the intestinal mucosa, hamper the intestines' capacity to absorb nutrients and induce an inflammatory immune response.

The modern broiler's gut – a high-performing, but sensitive system

However, in a system as high performing as the modern broiler's GIT, much less can lead to problems. From when they are day-old chicks up to slaughter, broilers go through several challenging phases during which they are more likely to show impaired gut functionality, e.g. after vaccinations or feed changes. Good management practices go a long way towards eliminating unnecessary stressors for the animals, but some challenging periods are unavoidable.

The transition from starter to grower diets is a classic situation when nutrients are very likely to not be well digested and build up in the gut, fueling the proliferation of harmful microbes. Immunosuppressive stress in combination with an immature intestinal microflora results in disturbances to the bacterial microbiota. At "best", this entails temporarily reduce nutrient absorption, in the worst case the birds will suffer serious intestinal diseases.

Phytomolecules – the intelligent alternative to antibiotics

To safeguard performance during stressful periods, poultry producers need to anticipate them and proactively provide effective gut health support. For many years, this support came in the form of antibiotic growth promoters (AGP): administered prophylactically, they were effective at keeping harmful enteric bacteria in check. However, due to grave concerns about the development of antimicrobial resistance, non-therapeutic antibiotics use has been banned in many countries. Alternatives need to focus on improving feed digestibility and strengthening gut health, attacking the root causes of why the intestinal microflora would become unbalanced in the first place.

Phytomolecules are secondary metabolites active in the defense mechanisms of plants. Studies have found that certain phytomolecules stimulate digestive enzyme activities and stabilize the gut microflora, "leading to improved feed utilization and less exposure to growth-depressing disorders associated with digestion and metabolism" (Zhai et al., 2018). With other trials showing positive effects on broilers' growth performance and feed conversion, the research indicates that phytomolecules might also specifically support chickens during challenging phases.

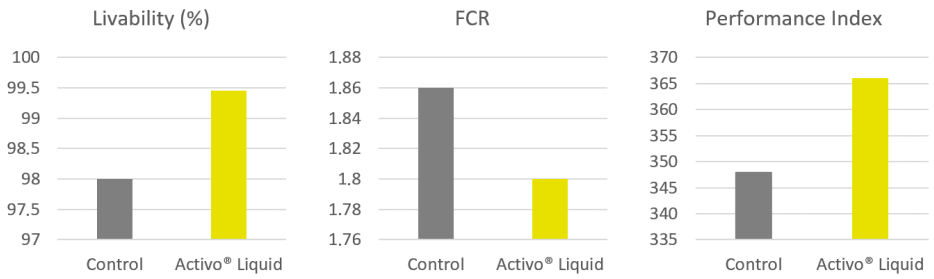
The effect of phytomolecules on broilers during a challenging phase

A study was conducted over a period of 49 days on a commercial broiler farm of an AGP-free integration operation in Japan. The farm reported gut health challenges in the second and third week of the fattening period due to vaccinations and changes to the animals' diets. The trial included 15504 Ross 308 broilers, divided into two groups. The negative control group included a total of 7242 birds, kept in another house.

All the birds were fed the standard feed of the farm. The trial group (8262 birds) received Activo Liquid, which contains a synergistic combination of phytomolecules, administered directly through the drinking water. Activo Liquid was given at an inclusion rate of 200ml per 1000L of water (3.3 US fl oz per gallon of stock solution, diluted at 1:128), from day 8 until day 25, for 8 hours a day.

The results are summarized in Figure 1:

Figure 1: Improved broiler performance for Activo Liquid group (day 49)



The Activo Liquid group clearly showed performance improvements compared to the control group. Livability augmented by 1.5%, while the feed conversion rate improved by 3.2%. This resulted in a more than 5% higher score in terms of the performance index.

Challenging times? Tackle them using phytomolecules

Poultry producers take great care to eliminate unnecessary sources of stress for their birds. Nonetheless, during their lifecycle, broiler chickens face challenging periods during which the balance of the intestinal microflora can easily become disturbed, with consequences ranging from decreased nutrient absorption to full-blown enteric disease.

The trial reviewed here showed that, after receiving Activo Liquid, broilers raised without AGPs showed encouraging performance improvements during a challenging phase of feed changes and vaccinations. Likely thanks to the activation of digestive enzymes and a stabilization of the gut flora, the broilers showed improved livability and feed conversion, thus delivering a much more robust performance during a critical phase of their lives. In times where the non-therapeutic use of antibiotics is no longer an option, phytomolecules allow poultry farmers to effectively support their animals during challenging times.

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Want antibiotic-free broilers? Raise low-AB breeders

Strong demand by consumers; restaurant chains and wholesalers for antibiotic-free (ABF) meat; the threat of antimicrobial resistance; and stringent regulations on the use of antibiotics – there are many good reasons for poultry producers to strive for antibiotic-free production systems. Crucially, to successfully produce poultry meat without antibiotics requires a paradigm shift that starts right at the parent stock level, with the antibiotic-free production of hatching eggs.

Broiler breeders' gut health is linked to progeny's performance

Broiler breeders' performance is measured in terms of how many saleable day old chicks (DOCs) per hen they produce. However, within a sustainable ABF production system (also known as No Antibiotics Ever or NAE), this parameter is not seen in isolation. Breeder hens' nutritional and health status not only affect the

number of DOCs they can produce, but also the transfer of nutrients, antibodies, microbiota and even contaminants, e.g. mycotoxins, to the egg – and therefore, their progeny's long-term health and performance.

This starts with egg formation, which requires several metabolic processes in the hen to function perfectly. If the hen's intestinal integrity is compromised, for example due to mycotoxins, she will absorb fewer nutrients, which in turn affects egg formation. Mycotoxicosis has particularly insidious effects for egg formation as it can damage the liver whose biosynthetic activities strongly impact on the egg's internal (yolk) and external (eggshell) quality.

Chick embryos depend on the maternal antibodies and nutrients deposited in the yolk, including vitamin D3, carotenoids, and fatty acids, to develop normally. Eggshell quality, among other things, affects the embryo's access to oxygen, which is especially important when it develops body tissues.

Hens' ability to form healthy eggs depends on their diet and health. Research indicates that, via the impact on egg formation, broiler breeders' feeding program quantifiably influences their progeny's immune system and intestinal health. There is indeed a direct relationship between parent and offspring's gut health because the chick's microbiome is in part also inherited from the hen. The impact on DOC quality is thus one of many dimensions to consider when calibrating one's broiler breeders feeding approach.

The challenge of feeding an ABF broiler breeder

Just as their offspring, breeder hens are genetically predisposed for rapid growth and muscle development. From rearing right through to the laying period, poultry nutritionists need to carefully balance their diets and moderate weight gain in order for hens to reach their reproductive potential.

Different stages of a breeder's life cycle come with different objectives – for example, good flock uniformity in the rearing period versus egg size and hatchability in the laying phase – and thus different requirements in terms of calories, amino acids, vitamins, and minerals. What remains constant is that the actual nutrient intake depends on intestinal health, determining both the breeders' performance and, via the impact on egg characteristics, its progeny's performance.

The feeding regimes adopted to avoid hens becoming overweight can have a negative effect on their gut flora. Without antibiotics as a tool to maintain or recover optimal gut function, even mild intestinal disorders can quickly become chronical impairments that negatively impact breeders' productivity. In ABF production systems, intestinal health therefore needs to be a central focus for the feeding strategy.

Can phytomolecules improve broiler breeders' performance?

Among the plethora of feed additives, phytomolecules, or secondary plant compounds, stand out as a class of active ingredients that may help to improve gut health and thereby reduce the use of antibiotics. Synthesized by plants as a defense mechanism against pathogens, phytomolecules combine digestive, antimicrobial and antioxidant properties.

Some studies have shown that phytomolecules-based products can increase broilers' body weight gain and improve laying hens' laying rate, egg mass and egg weight. Both broilers and laying hens responded to the inclusion of phytomolecules in their diet with inclusion rate-dependent improvements in feed conversion. To evaluate if phytomolecules could similarly improve broiler breeders' performance, two trials were conducted.

Study I: Effect of phytomolecules on laying performance during peak production

The first study was set up on a farm in Thailand. In total, 40000 Cobb broiler breeders (85% female, 15% male) were divided into two groups with 8500 hens (one house) in the control and 25500 (three houses) in

the trial group. Both groups were fed standard feed. The trial group additionally received a phytomolecules-based liquid complementary feed (Activo Liquid, EW Nutrition GmbH) via the waterline from week 24 to week 32 at a rate of 200ml/1000L during 5 days per week.

Activo Liquid was found to have a positive influence on laying performance (Figure 1). The average laying rate increased by 7.2% during the trial period, resulting in almost 3 additional hatching eggs per hen housed. A further indication of the beneficial influence that this particular combination of phytomolecules had on gut health was a 0.2% lower mortality.

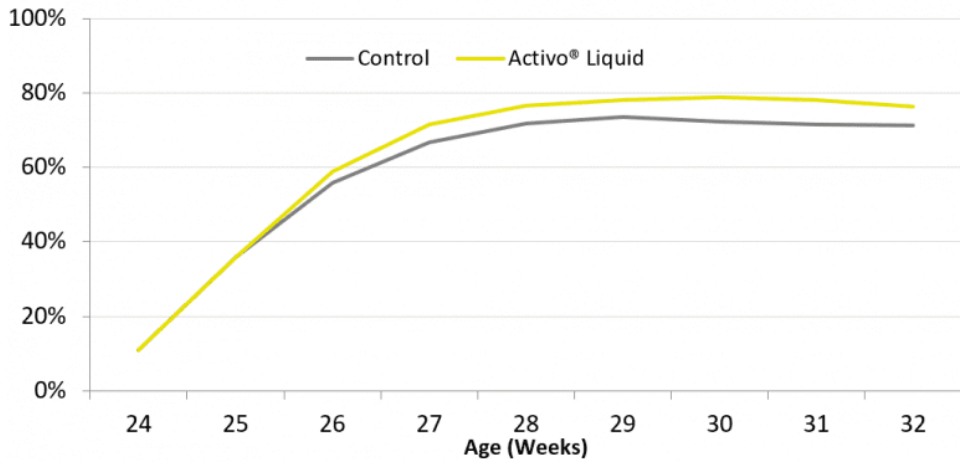

Figure 1: Laying rate (%) of breeder hens during first 9 weeks of production

Study II: Effect of phytomolecules on laying performance after peak production

For a second study, conducted in the Czech Republic, 800 female and 80 male Hubbard breeders (JA57 and M77, respectively) were divided into 2 groups with 5 replicate pens and 80 female and 8 male breeders per pen. The experiment started after the peak-production period, at 34 weeks of age and ended at 62 weeks of age. All animals received a standard mash diet. For one group a phytogenic premix (Activo, EW Nutrition GmbH) was added to the diet at a rate of 100g/MT.

The results indicate that Activo helped maintain the breeder hens' egg laying performance close to the breed's genetic potential (Figure 2). In the course of the experiment, Activo supplemented birds produced 3.6 more eggs than control birds, while consuming a similar amount of feed. As a result, feed consumption per egg produced was lower for birds receiving phytomolecules than for the control birds (169.9 versus 173.6g/d, respectively).

As hatchability was not influenced by the dietary treatment in this study (P>0.5), the 3.6 extra eggs resulted in 2.9 extra day old chicks per hen produced, during the post-peak period alone.

The microencapsulated, selected phytomolecules contained in Activo are likely to have improved gut health and feed digestibility, and thereby enhanced the animals' feed efficiency.

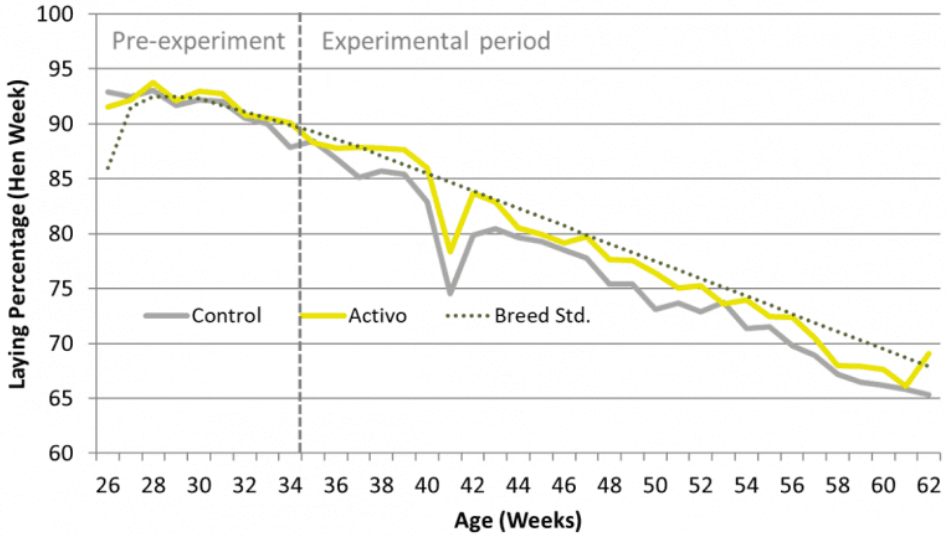

Figure 2: Laying rate (%) of breeder hens week 35 till 62

Chicken or egg? Antibiotic-free poultry production looks at the bigger picture

To successfully produce antibiotic-free poultry meat requires a systematic re-think of each component of the production process. Broiler breeders' lay the foundation for their progeny's health and performance via the egg. Breeder hens need to be in optimal health to consistently deliver optimal eggs. Without recourse to antibiotics for maintaining or recovering intestinal functionality, an effective ABF production needs to make gut health central to its feeding approach.

The trials reviewed demonstrate that selected phytomolecules quantifiably boost breeders' laying performance, increasing the number of hatching eggs and DOCs, while reducing mortality and feed consumption per egg produced. As part of an intelligent antibiotic reduction strategy, the right phytogenic products can be potent tools to help poultry producers achieve their NAE objectives.

by Technical Team, EW Nutrition

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