

No revision of the Feed Additives law, says the European Commission



The authorization and marketing of feed additives in the European Union is currently governed by [Feed Additives Regulation \(EC\) No 1831/2003](#), which came into effect in 2004. In 2021, the European Commission formalized [an initiative to revise it](#), stating as reasons both the focus brought by the Farm to Fork Strategy, as well as inherent complexities in phrasing, process, and more. Representatives of the EC's responsible unit, DG SANTE Unit G5, have now confirmed to EW Nutrition that, following consultations and analysis, **the revision of the legislation on the authorisation of feed additives will not happen under the current Commission's mandate.**

The revision was initially deemed necessary on several grounds:

- Not enough focus on sustainable animal farming
- Lack of flexibility in promoting technical and scientific innovation
- A lengthy authorization process
- Unnecessary administrative burden
- Ineffective imports control leading to unfair competition between EU and non-EU operators
- Dependency on imports from third countries for some additives (e.g., vitamins)
- Restrictions on the circulation of feed additives only intended for export
- Insufficient legal clarity and consistency for a few aspects of the Regulation, e.g. use of certain additives in drinking water or labelling provisions for worker safety provisions in various complementary but unclear Regulations
- Extensive, unnecessary labeling regulations that create physical and administrative burdens

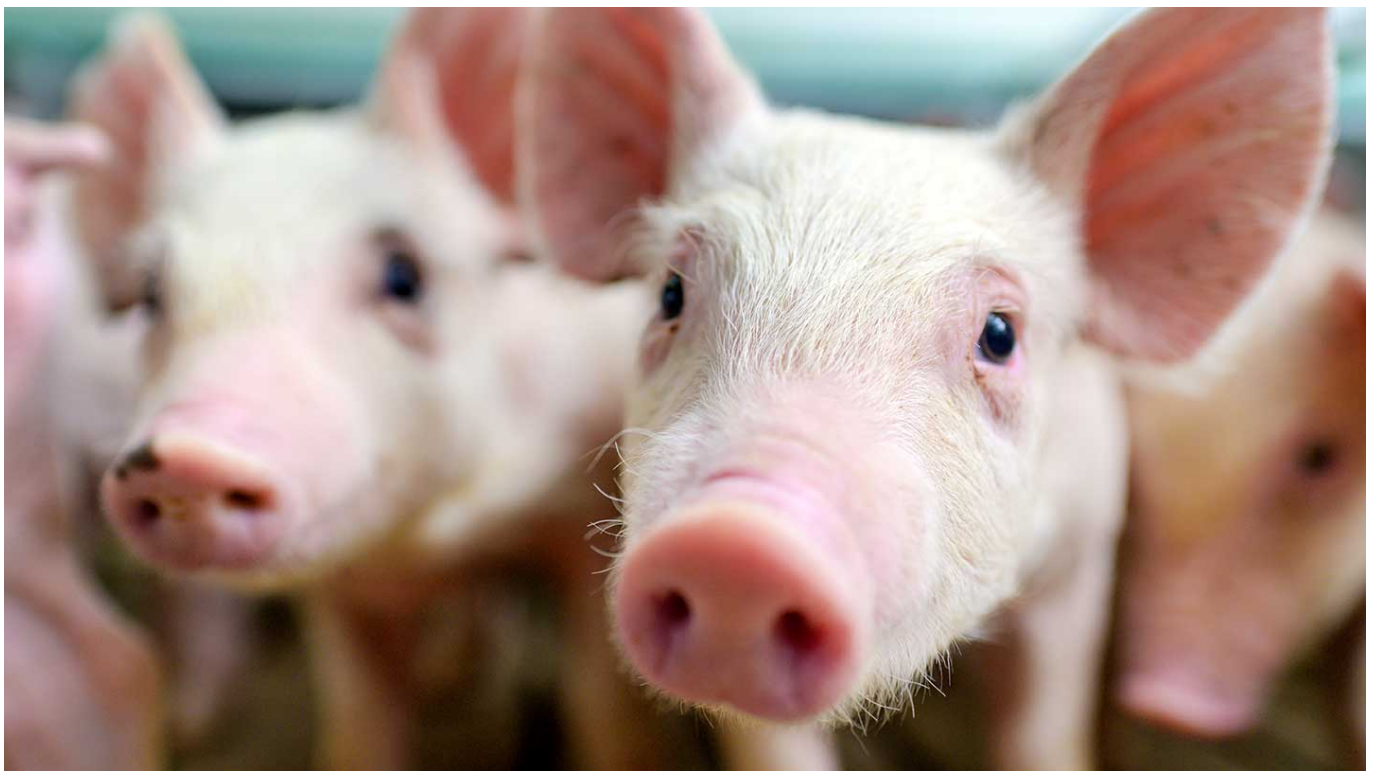
Near the end of the two-year assessment process, however, the response of European governmental, supra-national, and non-governmental bodies appears to have been lukewarm. Overall, the conclusion of the EC unit overseeing the process was that **“while a review of the framework would be useful, it**

does not appear necessary, considering the possibilities already granted by the existing legal framework.” In other words, applicants will have to use the existing mechanisms for applications, with no prospect for change in the near future.

Other strategies and regulations have also fallen through the cracks. For instance, the [EU Animal Health Strategy 2007-2013](#) has not been updated in 10 years and there are no plans to renew the initiative. This is likely because the Green Deal and the flurry of new or upcoming regulations related to it are expected to supplant the framework for protein production in the European Union.

As the mandate of the current EC ends in 2024, there is a slim chance that the feed additive authorization process might be made less cumbersome once a new commission takes over.

Minimizing Collateral Effects of Antibiotic Administration in Swine Farms: A Balancing Act



By **Dr Merideth Parke** BVSc, Regional Technical Manager Swine, EW Nutrition

We care for our animals, and antibiotics are a crucial component in the management of disease due to susceptible pathogens, supporting animal health and welfare. However, the administration of antibiotics in pig farming has become a common practice to prevent bacterial infections, reduce economic losses, and increase productivity.

All antibiotic applications have collateral consequences of significance, bringing a deeper consideration to their non-essential application. This article aims to challenge the choice to administer antibiotics by

exploring the broader impact that antibiotics have on animal and human health, economies, and the environment.

Antibiotics disrupt microbial communities

Antibiotics do not specifically target pathogenic bacteria. By impacting beneficial microorganisms, they disrupt the natural balance of microbial communities within animals. They reduce the microbiota diversity and abundance of all susceptible bacteria – beneficial and pathogenic ones... many of which play crucial roles in digestion, brain function, the immune system, and respiratory and overall health. Resulting microbiota imbalances may present themselves in animals showing health performance changes associated with non-target systems, including the nasal, respiratory, or gut microbiome^{7, 8, 14}. The gut-respiratory microbiome axis is well-established in mammals. [Gut microbiota health](#), diversity, and nutrient supply directly impact respiratory health and function¹³. In pigs specifically, the modulation of the gut microbiome is being considered as an additional tool in the control of respiratory diseases such as PRRS due to the link between the digestion of nutrients, systemic immunity, and response to pulmonary infections¹¹.

The collateral effect of antibiotic administration disrupting not only the microbial communities throughout the animal but also linked body systems needs to be considered significant in the context of optimal animal health, welfare, and productivity.

Antibiotic use can lead to the release of toxins

The consideration of the pathogenesis of individual bacteria is critical to mitigate potential for direct collateral effects associated with antibiotic administration. For example, in cases of toxin producing bacteria, when animals are medicated either orally or parenterally, mortality may increase due to the associated release of toxins when large numbers of toxin producing bacteria are killed quickly².

Modulation of the brain function can be critical

Numerous animal studies have investigated the modulatory role of intestinal microbes on the gut-brain axis. One identified mechanism seen with antibiotic-induced changes in fecal microbiota is the decreased concentrations of hypothalamic neurotransmitter precursors, 5-hydroxytryptamine (serotonin), and dopamine⁵. Neurotransmitters are essential for communication between the nerve cells. Animals with oral antibiotic-induced microbiota depletion have been shown to experience changes in brain function, such as spatial memory deficits and depressive-like behaviors.

Processing of waste materials can be impacted

Anaerobic treatment technology is well accepted as a feasible management process for swine farm wastewater due to its relatively low cost with the benefit of bioenergy production. Additionally, the much smaller volume of sludge remaining after anaerobic processing further eases the safe disposal and decreases the risk associated with the disposal of swine waste containing residual antibiotics⁴.

The excretion of antibiotics in animal waste, and the resulting presence of antibiotics in wastewater, can impact the success of anaerobic treatment technologies, which already could be demonstrated by several studies^{6, 11}. The degree to which antibiotics affect this process will vary by type, combination, and concentration. Furthermore, the presence of antibiotics within the anaerobic system may result in a population shift towards less sensitive microbes or the development of strains with antibiotic-resistant genes^{1, 12}.

Antibiotics can be transferred to the human food chain

[Regulatory authorities](#) specify detailed withdrawal periods after antibiotic treatment. However, residues of antibiotics and their metabolites may persist in animal tissues, such as meat and milk, even after this period. These residues can enter the human food chain if not adequately monitored and controlled.

Prolonged exposure to low levels of antibiotics through the consumption of animal products may contribute to the emergence of antibiotic-resistant bacteria in humans, posing a significant public health risk.

Contamination of the environment

As mentioned, the administration of antibiotics to livestock can result in the release of these compounds into the environment. Antibiotics can enter the soil, waterways, and surrounding ecosystems through excretions from treated animals, inappropriate disposal of manure, and runoff from agricultural fields. Once in the environment, antibiotics can contribute to the selection and spread of antibiotic-resistant bacteria in natural bacterial communities. This contamination poses a potential risk to wildlife, including birds, fish, and other aquatic organisms, as well as the broader ecological balance of affected ecosystems.

Every use of antibiotics can create resistance

One of the widely researched concerns associated with antibiotic use in livestock is the development of antibiotic resistance. The development of AMR does not require prolonged antibiotic use and, along with other collateral effects, also occurs when antibiotics are used within recommended therapeutic or preventive applications.

Gene mutations can supply bacteria with abilities that make them resistant to certain antibiotics (e.g., a mechanism to destroy or discharge the antibiotic). This resistance can be transferred to other microorganisms, as seen with the effect of carbadox on *Escherichia coli*⁵ and *Salmonella enterica*² and the carbadox and metronidazole effect on *Brachyspira hyodysenteriae*¹⁵. Additionally, there is an indication that the zinc resistance of *Staphylococcus* of animal origin is associated with the methicillin resistance coming from humans³.

Consequently, the effectiveness of antibiotics in treating infections in target animals becomes compromised, and the risk of exposure to resistant pathogens for in-contact animals and across species increases, including humans.

Alternative solutions are available

To successfully minimize the collateral effects of antibiotic administration in livestock, a unified strategy with support from all stakeholders in the production system is essential. The European Innovation

Partnership – Agriculture⁹ concisely summarizes such a process as requiring...

1. Changing human mindsets and habits: this is the first and defining step to successful [antimicrobial](#) reduction
2. Improving pig health and welfare: Prevention of disease with optimal husbandry, hygiene, [biosecurity](#), vaccination programs, and [nutritional support](#).
3. Effective antibiotic alternatives: for this purpose, [phytomolecules](#), pro/pre-biotics, organic acids, and immunoglobulins are considerations.

In general, implementing responsible antibiotic stewardship practices is paramount. This includes limiting antibiotic use to the treatment of diagnosed infections with an effective antibiotic, and eliminating their use as growth promoters or for prophylactic purposes.

Keeping the balance is of crucial importance

While antibiotics play a crucial role in ensuring the health and welfare of livestock, their extensive administration in the agricultural industry has collateral effects that cannot be ignored. The development of antibiotic resistance, environmental contamination, disruption of microbial communities, and the potential transfer of antibiotic residues to food pose significant challenges.

Adopting responsible antibiotic stewardship practices, including veterinary oversight, disease prevention programs, optimal animal husbandry practices, and [alternatives to antibiotics](#), can strike a balance between animal health, efficient productive performance, and environmental and human health concerns.

The collaboration of stakeholders, including farmers, veterinarians, policymakers, industry and consumers, is essential in implementing and supporting these measures to create a sustainable and resilient livestock industry.

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Layer production losses: causes, types, solutions



By **Technical Team**, EW Nutrition India

Consumer demand drives egg production. With 10 billion people on the planet by the year 2050 (1), producers are under more pressure to provide more protein of higher quality. Modern production practices help extend the laying cycle of commercial flocks to 90–100 weeks. The volume of eggs produced worldwide has thus [increased by more than 100%](#) since 1990. Consumers are pushing not just for more eggs, but also for larger eggs. Due to these shifting requirements, farmers and integrators are under pressure to meet demand. As a result, the birds are under metabolic stress to meet needs, which can compromise eggshell quality, laying consistency, and gut health.

Gut health is a key factor in achieving maximum productive potential and laying rate, not only because it's a key factor for digestion and the absorption of nutrients but also because it's an essential component of the bird's immune system.

In today's layer production, when the cycle is increasing and overall demand to limit the use of antibiotics is growing, laying persistency, eggshell quality, and gut health are critical topics. But what does a laying hen's healthy gut mean?

Birds need a healthy gut to maximize production. Genetics, nutrition, management and biosecurity all affect production parameters. A gut with a diverse pH and healthy microbiota prevents infections. Gut health is affected by Goblet cells, paneth cells, endocrine cells, absorptive enterocytes, tight junctions, GALT, and mucus. To deal with potential challenges and ensure optimal bird performance, a complex approach is needed, consisting of optimal carbohydrates, proteins, amino acids, minerals, vitamins, enzymes, organic acids, and management strategies.

Vital amino acids, Zn, Vit E, Se, etc. must be supplemented according to the production status and environment to establish good immunity. Maximum production requires a stress-free, hormonally balanced, clean environment, as well as optimal nutrition. Especially given the push for reduced antibiotics and rising welfare and food standards, particularly from the expansion in cage-free farming, producers need to pay considerable attention to the issues of maintaining a healthy gut with these added challenges. Several aspects must be considered when it comes to gut health.

Factors affecting layer gut health

- Breed
- Management
- Environment
- Diet – Nutrients and Anti-Nutritional Factors (ANFs)
- Feed management
- Stress
- Toxins (Mycotoxins and endotoxins)

- Pathogens
- Microbiota
- Parasites
- Physiology
 - Metabolism
 - Immunity
 - Endocrine system

Feed and water are essential

Both vectors create a connection between the external and internal environment of the hen, increasing the possibility of a negative effect on the intestinal balance.

Some common influences:

- Anti-nutritional factors (non starch polysaccharides and anti-trypsin factors)
- Water, raw material and feed contaminants (E. Coli, Salmonella, mycotoxins (Fig. 1) etc.)
- Sudden changes in formulation
- High density diets – excess of nutrients

- Bird physiology. How, different organs and the endocrine system respond against challenges
- Gut microbiota. Represented by the balance between pathogenic and commensal flora. Latter being the one involved in the development of intestinal morphology and structure, immune modulation and supporting digestion and absorption processes.

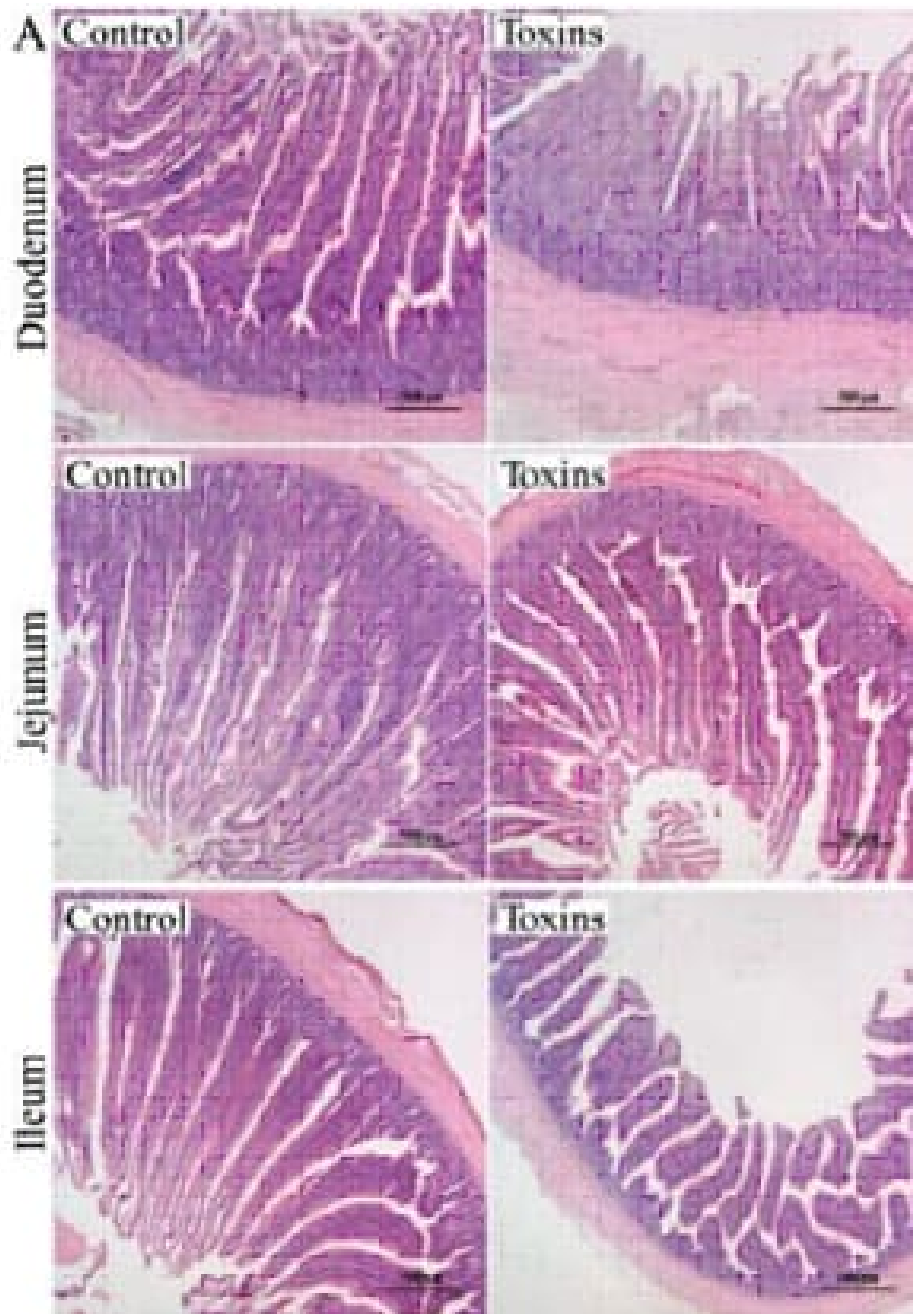


Fig. 1: Effects of dietary mycotoxins on histopathology of the duodenum, jejunum, and ileum Adapted from Zhao et al., 2021 (3)

Layer gut health: An increasing concern

Nowadays the gut health of the layer matters more than ever. In many countries, consumer preferences have been shifting towards eggs produced in non-cage environments and, in these new housing systems, birds are in closer contact with the litter and are more prone to the proliferation of gut pathogens.

Traditionally, layers were housed in cages, which benefited egg producers by making better use of available space and increasing productivity. This resulted in more birds per house, more automated operations, better management, improved hygiene, decreased incidence of infectious diseases, and cheaper feed consumption and production costs.

Cages, on the other hand, pose other health and welfare concerns. They limit or prevent mobility, ground scratching, wing-flapping, and soaring. As a result, there is increasing pressure for birds to be cage-free and, eventually, free-range. [The European Commission stated](#) that, by the end of 2023, a legislative proposal will phase out, and eventually prohibit, the use of cages for a variety of farm animals, resulting in

an increase in the number of layers reared in a cage-free system.

According to the [Egg Track Report](#) (2021), 219 egg farmers, retailers, food service firms, and hotel chains have pledged to transition completely to cage-free eggs by 2025, with 47 of these companies expanding their commitments to encompass their global supply. This means that farmers and integrators will face increased pressure to migrate from a cage system to a cage-free system. As a result, it is necessary to consider new issues or challenges that may be exacerbated by transitioning to a cage-free production system.

Gut health-associated production losses in laying hens

Water (70%), proteins (10%), and lipids (20%) make up egg yolks. The yolk lipids are triglyceride-rich lipoproteins that are produced in the liver and transferred to the ovary. Cholesterol transported to the egg yolk by lipoproteins is also deposited there, demonstrating the importance of the liver in egg formation.

The gut plays an important role in preventing liver damage by acting as a barrier against dangerous viruses and toxins that could enter the bloodstream and reach this key organ. Efficient feed digestion and absorption of nutrients are essential for the hen to obtain the “material” for maintenance, growth, and egg production.

The Association of Veterinarians of Egg Production in the US found in 2014 that gastrointestinal difficulties cause 40% of health issues during the pullet phase and 50% during production. Coccidiosis, necrotic enteritis, and feed passage were the biggest threats from these gastrointestinal illnesses.

Aging reduces digestive health, causing nutrient digestion and absorption problems and immunological issues. As a result, eggs produced by older hens show increased micro-cracks, gross cracks, and a higher number of dirty eggs.

Eggshell quality issue

Poor intestinal physiology can impair mineral absorption, notably calcium. When this happens, hens utilise the calcium from their bones, but if the problem persists, these stores may diminish and thin-shelled eggs may appear, increasing the percentage of broken eggs. Shell-less eggs are possible.

Bone fractures

In continuation with what was described in the previous point, the bird’s skeletal system weakens due to the use of calcium reserves of the bones, which leads to bone fractures, such as the head of the femur, and other locomotor problems of similar pathogenesis.

Increase in soiled eggs percentage

Deficient intestinal physiology may also cause intestinal flora imbalance. Certain germs proliferate excessively, harming the mucosa and affecting faeces consistency. This raises the number of dirty eggs, which harms consumers due to cross-contamination.

Internal egg quality changes

Due to the alteration of the nutritional function of the intestine, feed digestion and nutrient absorption is affected, and this leads to a decrease in their concentration in the egg. This deficiency causes yolk pigmentation problems, poorer egg nutritional value, and worsening of the Haugh Units, among other issues.

Low egg laying percentage and small egg size

Related to the previous point, the alteration of the nutritional functions of the intestine will also decrease the percentage of egg laying. This is because the bird will not absorb enough nutrients and minerals to cover the needs for egg production (both for the metabolic process and to form the egg). The mentioned problems, derived from inadequate intestinal physiology, lead to poor qualitative and quantitative egg production, which is, in most cases, very difficult to reverse in the short term, and that leads to significant economic losses.

Strategies for gut health maintenance

During the production cycle, the gastrointestinal health of laying hens has a substantial impact on both efficiency and profitability. During peak egg production, chickens often cannot consume enough feed to meet their protein and calcium requirements. This stress can disrupt the gut microbiota, resulting in pathogenic bacterial outbreaks. Infections with *Escherichia coli* and *Clostridium perfringens* are prevalent in laying hens. Antibiotics would be administered to the birds to deter severe mortality.

Antibiotics, on the other hand, have hidden costs because eggs produced during antibiotic treatment and withdrawal cannot be marketed for human consumption. Furthermore, antibiotic misuse, such as using too little or for too short a time, might contribute to the development of antibiotic resistance.

A variety of non-drug substances have been promoted as aids to enhance gut health and to [mitigate the risks of coccidiosis](#) and necrotic enteritis in antibiotic-free production. These products include phytogenic additives, probiotics, prebiotics, organic acids, yolk immunoglobulins, bacteriophages, yeast products, and others.

Probiotics and competitive exclusion (CE) cultures are available for hatchery application, usually by spray, and most of the alternatives are available for feed or water administration. Because of logistical issues, producers usually prefer feed-administered products, especially if intended for large-scale applications for prevention.

General water management guidelines

1. Ensure adequate cleaning between flocks:
 - Removing biofilm (e.g., 25-50 ppm Hydrogen peroxide in the water line for 24-72 hours, then flush)
 - Removing scale (target a pH of 5 with weak acid, e.g. citric acid – leave in line for 24 hours, then flush)
2. Prior to bird arrival
 - Use bleach solution in standing water
 - Flush just before birds arrive
3. Throughout the life of the flock
 - Sanitize (e.g., Chlorine [2-4 ppm] or Chlorine dioxide [0.8 ppm])
 - Acidify water (pH 5.5-7)
 - Perform waterline biofilm removal at regular intervals throughout the life of the flock (biofilms can form in 6 weeks)
 - Routinely check ORP (oxygen reduction potential) at the drinker furthest from the water tank to check the efficacy of sanitation; it should be >650 mv)

Gut health additives

Many gut health solutions can be added to water, included in feed at the feed mill, or top-dressed at the farm. Gut health supplements work differently, making selection challenging. Some gut health products

encourage beneficial bacteria, gut tissue formation, digestion, or pathogen inhibition. Thus, while choosing a gut health product, it's important to determine the root cause of the challenge and make sure the product can address the problem.

The right products are also effective in antibiotic reduction initiatives. However, their prophylactic use should be considered as an alternative option. A strategic method is to deliver a gut-friendly substance at key periods in the chicken's life.

What are the key periods?

Development, transition, and maintenance are three primary stages in the gut development chain (see Figure 2).

1. Promote bacterial colonization as well as tissue and immunological improvement during development.
2. The transition stage is when feed changes, vaccinations, and handling affect the intestinal environment. These events can alter the gut environment and enhance malabsorption and bacterial overgrowth.
3. The gut has ceased developing and reached balance in the maintenance stage, but management or microbial problems can upset it, thus gut tissue support is still necessary.

Understanding the needs of the gut at different points in the bird's life and the main goals of gut health support at these times is important when designing gut health strategies.

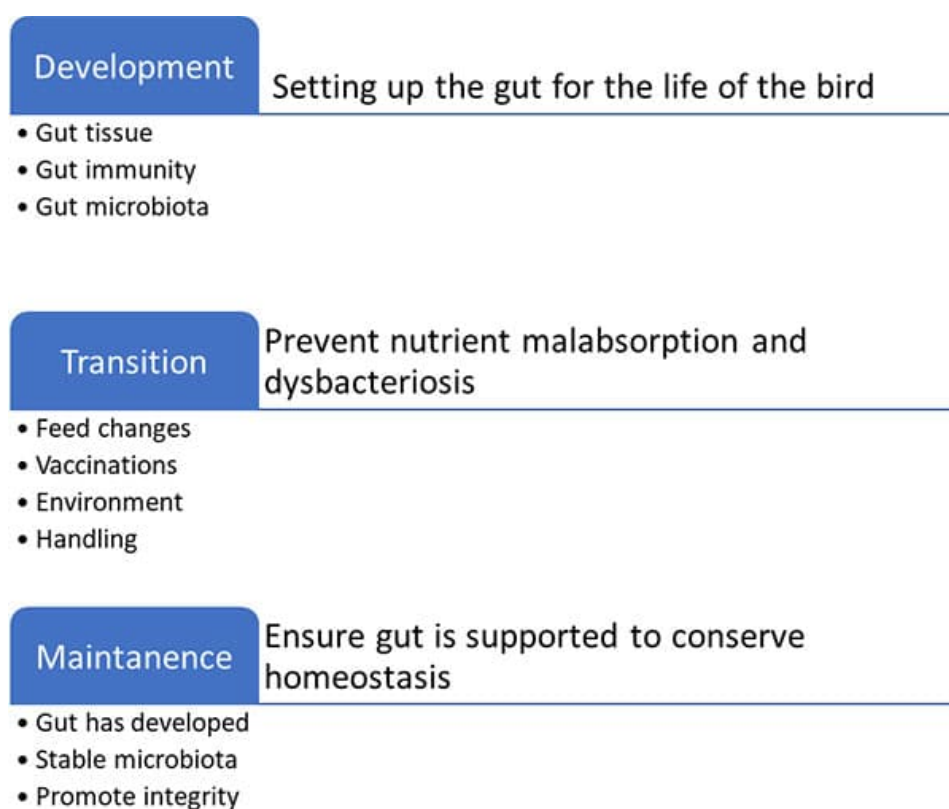


Fig2: Gut need assessment and management strategy

Phytomolecules mitigate gut health challenges

Multiple scientific studies highlight phytomolecules as one of the key elements in antibiotic-free production. These substances support digestion and improve the utilization of nutrients, resulting in a higher daily weight gain, uniform flock, and better feed utilization.

They also have a proven anti-inflammatory effect, as shown in Figure 3. NF-κB is a critical regulator for the expression of genes involved in inflammation. It has been demonstrated that NF-κB plays a novel role in the mechanism of increased epithelial permeability induced by inflammatory factors (including LPS and TNF-α) (5).

Phytomolecules, when combined with effective delivery and synergistic value inside the animal, also have a proven antimicrobial effect and help prevent the development of resistance. Various forms of stresses and insults from feed water and the environment cause oxidative stress and thereby impaired tight junctions, resulting in a leaky gut. Leaky gut has multiple consequences, ranging from poor flock performance to wet litter and raised ammonia levels. Phytomolecules are well documented for their NF-κB inhibitory and anti-inflammatory properties (6). They also help curb oxidative stress and maintain gut integrity. [The right product](#) will also be mild on the beneficial flora, showing selective antimicrobial activity and preserving the balance of the gut microbiota.

Finding the right product (perfect formulation and technology to counter high volatility, offer high thermostability, and yet provide effective delivery inside the animal) is of paramount importance for desired results.

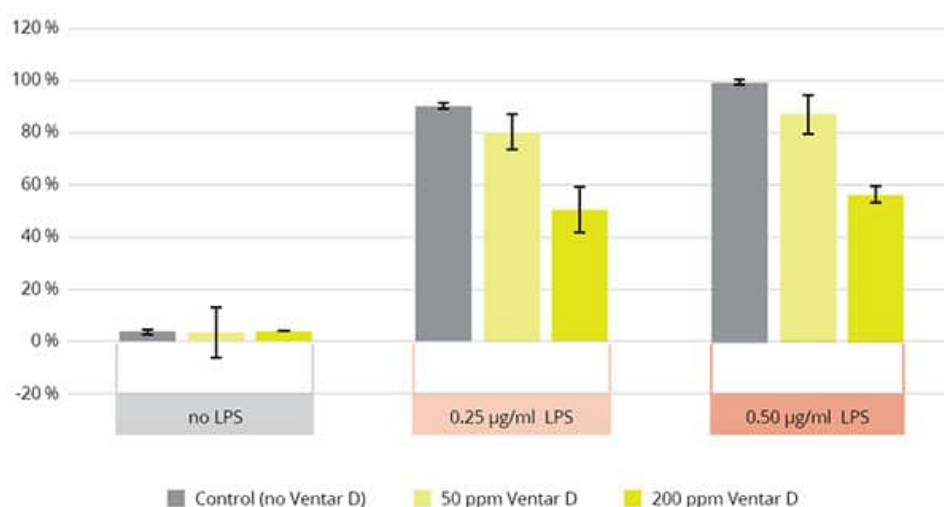


Figure 3. NFκB activity with phytomolecule-based product Ventar D (EW Nutrition)

Conclusion

Optimal growth and FCR in food-producing animals depend on intestinal health. Researchers have studied gut flora, function, and immunity. Regional variations in chicken production, management styles, environment, disease challenge, and feed raw materials complicate gut health maintenance. Consequently, appropriate bird management techniques are essential to bird health, welfare, and performance.

Due to the recent focus on reducing or restricting antibiotic use, intestinal problems have increased, often resulting in productivity losses. This has led to the development of several feed additives that can improve intestinal microbiota, prevent pathogens from adhering to epithelial cells, and boost immune response.

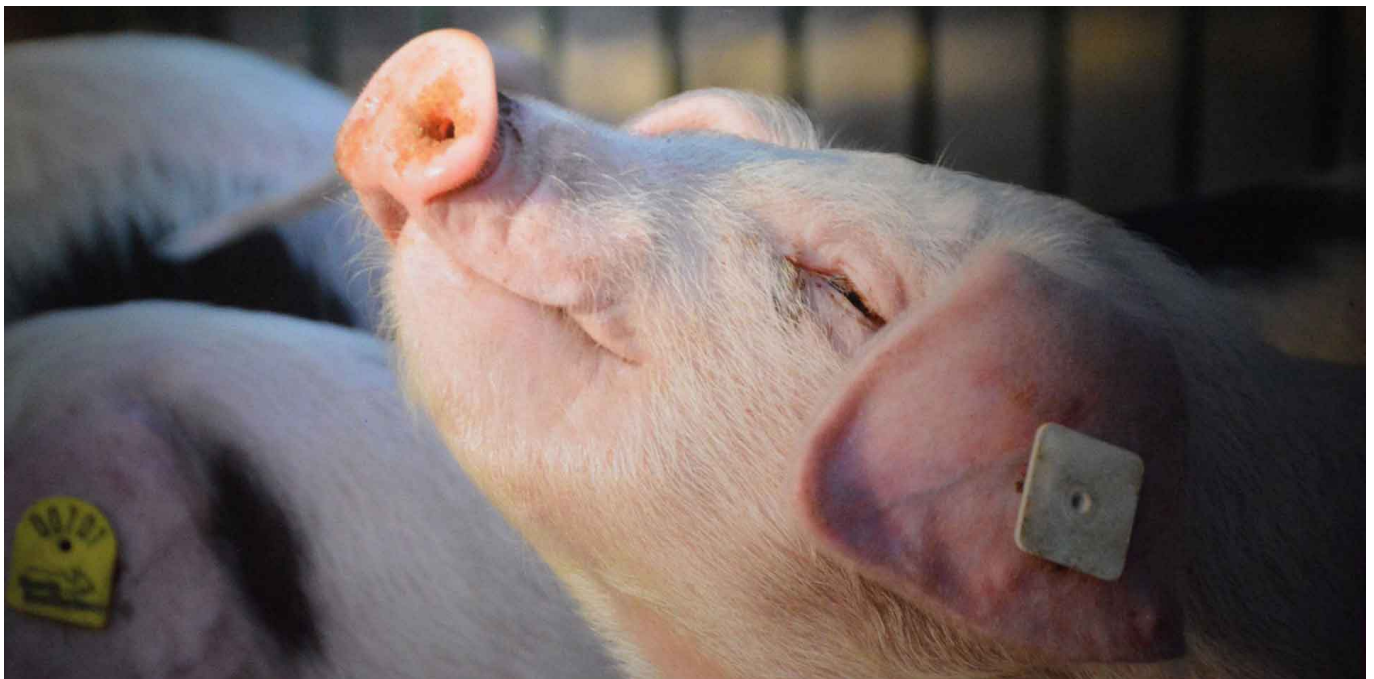
Probiotics, prebiotics, organic acids, organic acid blends (protected or not), phytobiotics, and feed enzymes are everywhere. Feed additive performance depends on parameters like hen age, management, production method, genetics, etc. It also depends on additive formulation, a multi-layered mode of action, and on a coating technology that leads to effective release of ingredients in the GIT.

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Respiratory challenges in pigs: Plants to the rescue!



By **Dr. Inge Heinzl**, Editor, *EW Nutrition*

Nowadays, intensive livestock farming with high [stocking densities](#) causes stress in the animals and affects the [immune system](#)^{9, 13}. The increase in respiratory diseases with associated losses and costs is only one of the consequences. Due to antimicrobial resistance, antibiotics should only be used in critical cases, so effective alternatives are requested to support the animals.

Respiratory problems are a conjunction of

several factors

It already has a name: [PRDC](#) or the Porcine Respiratory Disease Complex describes the cooperation of viruses, bacteria, and non-infectious factors such as environmental conditions (e.g., insufficient ventilation), stocking density, management (e.g., all-in-all-out only by pens and not for the whole house) and pig-specific factors such as age and genetics, altogether causing respiratory issues in pigs. Non-infectious factors such as high ammonia levels weaken the immune system and lay the foundation for, e.g., mycoplasmas which damage the ciliated epithelial cells in the upper respiratory tract, the first line of defense, and pave the way for [PRRS viruses](#). They, on their part, enter the respiratory tract embedded in inhaled dust. There, they harm the macrophages and breach a further barrier of defense. Another pathfinder is the Porcine Circovirus 2 (PCV2), which destroys specific immune cells and leads to a generally higher susceptibility to infectious agents. Bacteria such as *Pasteurella multocida* or *Streptococcus suis* further on can cause [secondary infections](#)^{7, 20, 22}. Also, the combination of [mycoplasma hyopneumoniae](#) and porcine circovirus, both typically low pathogenic organisms, leads to severe respiratory disease¹⁵.

Restricted respiratory function impacts growth

The main tasks of the respiratory tract are to take in oxygen from the air and to pump out the CO₂ entailed by the catabolism of the tissue. In pigs, however, the respiratory tract is also responsible for thermoregulation, as pigs don't have perspiration glands. The animals must get rid of excessive heat by rapid breathing. If the respiratory function is affected due to disease, thermoregulatory capacity is reduced. The resulting lower feed intake leads to [decreased growth performance](#) and less economic profit¹⁷. One of the first studies concerning this topic was conducted by Straw et al. (1989)²¹. They asserted that, with every 10 % more affected [lung tissue](#), daily gain decreased by about 37g. This negative correlation between affected lung tissue and weight gain could be confirmed by Paz-Sánchez et al. (2021)¹⁸. They saw that animals with >10% [lung parenchyma](#) impacted by cranioventral bronchopneumonia needed a longer time to market (208.8 days vs. 200.8 days in the control), showed a lower carcass weight (74.1 kg vs. 77.7 kg in the control group) and, therefore, also a lower daily gain (500.8 g/day compared to 567.2 g/d). In another study, Pagot and co-workers (2007)¹⁶ observed 7000 pigs from 14 French farms. They saw a significant negative correlation ($p < 0.001$) between the prevalence of [pneumonia](#) and growth and a weight gain loss of about 0.7 for each point of pneumonia increase.

Plant extracts support pigs with different modes of action

People have always used herbal substances to cure illnesses, be it willow bark for pain, chamomile for anti-inflammation or an upset stomach. Ribwort and thyme are used as cough suppressants, and eucalyptus and menthol help you breathe better. What is good for humans can also be used for pigs. To use [plant extracts](#) efficiently, it is crucial to know their specific modes of action. Due to their volatile nature, essential oils can directly reach the target site, the respiratory tract, via inhalation¹.

1. Plant extracts can act as an antimicrobial

Many essential oils show some degree of antimicrobial activity. So, the oils of, e. g., oregano, tea tree, lemongrass, lemon myrtle, and clove are effective against a wide range of gram-positive and gram-negative bacteria. LeBel et al. (2019)¹² tested nine different oils against microorganisms causing respiratory issues in pigs. They found the [oils of cinnamon, thyme, and winter savory](#) the most effective

against *Streptococcus suis*, *Actinobacillus pleuropneumoniae*, *Actinobacillus suis*, *Bordetella bronchiseptica*, *Haemophilus parasuis*, and *Pasteurella multocida*, with MICs and MBCs from 0.01 to 0.156%.

Not only the direct bactericidal effect is important. 1,8 cineol, e.g., although often considered to have only marginal or no [antimicrobial](#) activity¹⁰, effectively causes leakage of [bacterial membranes](#)² and allows other harmful substances to enter the bacterial cell. However, cineol possesses noted antiviral properties.

2. Plant extracts can have mucolytic, spasmolytic, and antitussive effects

In the case of respiratory disease, mucolytic and spasmolytic characteristics of phytomolecules are decisive in allowing efficient respiration. Mucolytic substances dissolve the mucus, make it more liquid and facilitate the removal from the respiratory tract by the ciliated epithelium. As liquifying the mucus with [essential oils](#) or phytomolecules is related to local irritation, dosage and application form are of the highest importance⁵.

The “cleanup” is called [mucociliary clearance](#). There are also substances that do not dissolve the mucus but stimulate the mucociliary apparatus itself and increase mucociliary transport velocity¹.

[Spasmolytic](#) activity on airway smooth muscle is shown, for example, by menthol⁸ or the essential oil of [eucalyptus tereticornis](#)⁴. Menthol showed [antitussive](#) effects¹¹.

3. Plant extracts can have immune-modulatory and anti-inflammatory effects

If animals are suffering from a respiratory disease or are in danger of catching one, a supportive influence on the immune system is helpful. One thing is to make vaccination more effective. Mieres-Castro et al. (2021)¹⁴ figured out that the combined application of [influenza vaccine and cineol](#) to mice resulted in a longer survival time, less inflammation, less weight loss, a lower mortality rate, less pulmonary edema, and lower viral titers after a challenge with the virus seven days after the vaccination than the mice without cineol.

On the other hand, if the animals are already ill, strengthening their immune defense is essential. Li et al. (2012)¹³ showed that [interleukin-6](#) concentration was lower ($p<0.05$) and the tumor necrosis factor- α level was higher ($p<0.05$) in the plasma of pigs fed a diet with 0.18% thymol and cinnamaldehyde than in the negative control group. Also, the lymphocyte proliferation for pigs fed the diet with thymol and cinnamaldehyde increased significantly compared with the negative control ($p<0.05$).

4. Plant extracts can act as an antioxidant

There are respiratory diseases in which reactive oxygen species (ROS) play an important role. In these cases, the antioxidant activity of phytomolecules is of interest. Here again, Li et al. (2012)¹³ asserted that a diet with 0.18% thymol and cinnamaldehyde increased the total [antioxidant](#) capacity level ($p<0.05$) in pigs compared to a negative control group.

Can Baser & Buchbauer (2010) described [eucalyptus](#) oil containing 1,8-cineole, the monoterpene hydrocarbons α -pinene (10–12%), p-cymene, and α -terpinene, and the monoterpene alcohol linalool, is used to treat diseases of the respiratory tract in which ROS play an important role.

5. Plant extracts reduce the production of ammonia

High concentration of ammonia in the pig house stresses the pigs' respiratory tract and makes them susceptible to disease. Ammonia develops when feces and urine merge and the enzyme urease degrades them. Yucca extract, containing a high percentage of saponins, can reduce ammonia emissions in animal houses. [Ehrlinger \(2007\)](#)⁵ supposes that the glyco-components of the [saponins](#) bind ammonia and other harmful gases. Another explanation can be the decreased activity of [urease](#) shown in a trial with rats¹⁹ or the reduction of total nitrogen, [urea nitrogen](#), and ammonia nitrogen in sow manure³.

6. Plant extracts often show diverse modes of useful action against respiratory issues

Due to their natural task – protecting the plant – essential oils typically do not show only one beneficial activity for us. [Camphene](#), for example, in *Thymus vulgaris*, shows expectorant, spasmolytic, and antimicrobial properties and is used in treating respiratory tract infections. Menthol can be effectively used in cases of asthma due to its bronchodilatory activity on smooth muscle, its interaction with cold receptors, and the respiratory drive. Menthol acts antitussive in low concentration, gives the impression of decongestion and reduces respiratory discomfort and sensations of dyspnea.

[Cineol](#), on its part, acts antimicrobial, antitussive, bronchodilatory, mucolytic, and anti-inflammatory. It promotes ciliary transport and improves lung function^{1, 6}. [Mucolytic, antioxidant, antiviral, and antibacterial](#) activity is ascribed to thymol⁵.

Trial shows: phytomolecules help to keep respiratory diseases in check

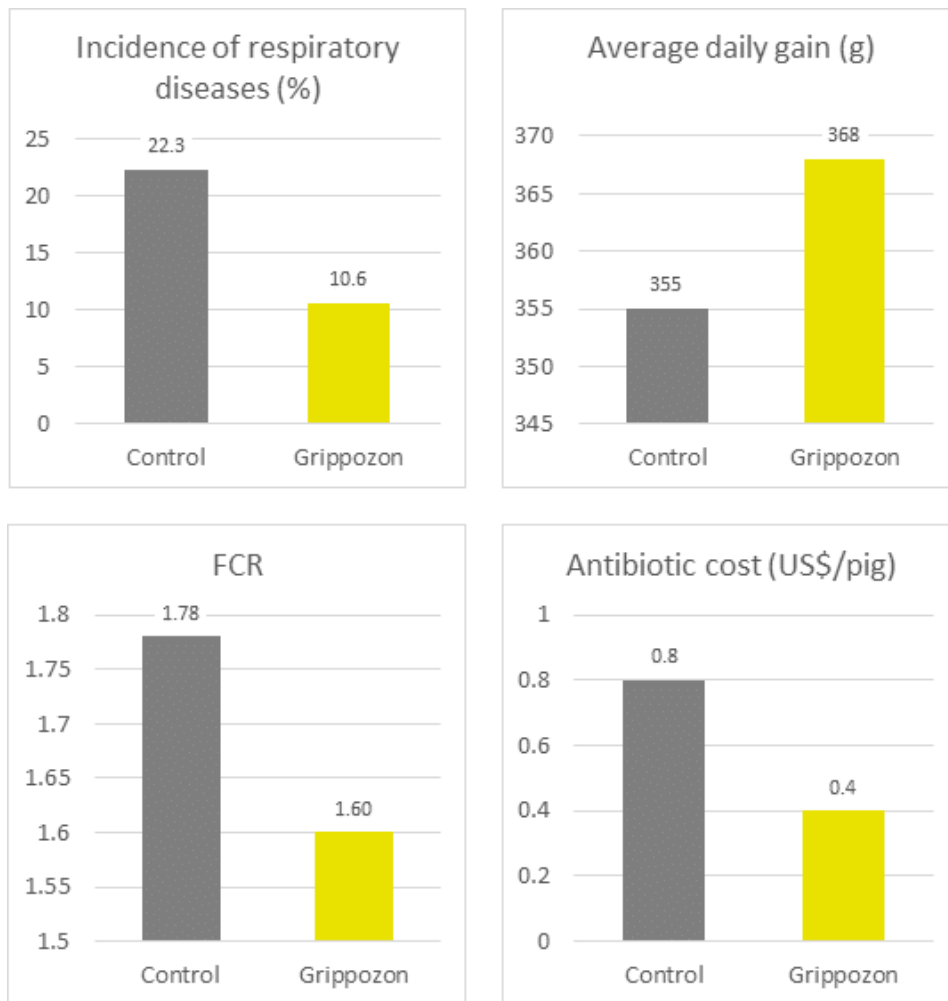
A field study was conducted on a Philippine piglet farm with a history of chronic respiratory issues during the growing phase, with a morbidity of about 10-15%. In this study, a supplement for water containing phytomolecules that support animals against respiratory diseases ([Grippozon](#)) was tested. For the trial, 360 randomly selected 28-day-old pigs (average weight: 6.64 ± 0.44 kg) were divided into two groups with 6 replications per group and 30 piglets per replication. All piglets came from sows raised antibiotic-free, and the piglets received antibiotics neither upon weaning except in case of symptoms (scouring: Baytril-1 mL/pig; respiratory disease: Excede – 1mL/pig). All piglets received the same feed and a regular water therapy regimen:

Week 1 (1st week after weaning):	• multivitamins, amino acids – 200-400 g/1000 L of water • water acidifier I (citric acid +enzyme) – 2 L/1000 L
Week 2-10:	• water acidifier II (citric acid) – 300-400 mL/1000 L

Control group: no additional supplements

Grippozon group: Addition of 250 mL of [Grippozon](#) per 1000 L of water

As parameters, the incidence of respiratory disease, final weight, daily gain, FCR, and antibiotic cost, were recorded.



The phytomolecules-containing product reduced the incidence of respiratory diseases by 52 %, leading to a 53% lower cost for antibiotic treatment. The animals showed better growth performance (600 g higher average weight and 13 g higher average daily gain), altogether resulting in an extra cost-benefit of 1.76 US\$ per pig.

Reduction in disease and medication ensures healthier pigs in the Grippozone-supplemented group, reflected by better performance.

We have means at hand to reduce the use of antibiotics

Respiratory disease is a big problem in pigs. Due to the still high occurrence of antimicrobial resistance, it is essential to reduce antibiotic use as much as possible. Phytomolecules offer the possibility to strengthen the animals' health so that they are less susceptible to disease or support them when they are already infected. With the help of phytomolecules, we can reduce antibiotic treatments and help keep antibiotics effective when their use is indispensable.

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Rancidity in fats and oils: Considerations for analytical testing



By **Dr. Ajay Bhoyar**, Global Technical Manager – Poultry, EW Nutrition

Rancidity testing is essential in the feed industry, as a key indicator of product quality and shelf life. It is conducted to determine the level of oxidation in samples of feed or feed ingredients and it can be performed through a number of analytical methods.

Rancidity is the process by which fats and oils in food become degraded, resulting into off-odor/flavor, taste, and texture. This process is caused by the oxidation of unsaturated fatty acids and can be accelerated by factors such as exposure to light, heat, and air. Rancidity can occur naturally over time, but it can also be accelerated by improper storage or processing of animal products. Fats are highly susceptible to degradation due to their chemical nature.

How does oxidative rancidity occur?

Oxidation occurs when an oxygen ion replaces a hydrogen ion within a fatty acid molecule and higher numbers of double bonds within the fatty acid increase the possibility of autooxidation. Oxidative rancidity results from the breakdown of unsaturated fatty acids in the presence of oxygen. Light and heat promote this reaction, which results in the generation of aldehydes and ketones – compounds which impart off-odors and flavors to food products. Pork and chicken fat demonstrate a higher degree of unsaturated fatty acids compared with beef fat and are therefore more prone for rancidity.

Oxidation: a three-step process

Fat/oil oxidation is a three-step process (Initiation, Propagation and Termination). Therefore, the oxidation products depend on the time. In the first phase, called Initiation, the formation of free radicals begins and accelerates.

Once the initial radicals have formed, the formation of other radicals proceeds rapidly in this second phase called Propagation. In this part of the process, a chain reaction of high energy molecules, which are variations of free radicals and oxygen, are formed and can react with other fatty acids. These reactions can proceed exponentially, if not controlled. Also in this phase, the rate of peroxide radical formation will reach equilibrium with the rate of decomposition to form a bell-shaped curve.

In the final phase, called Termination, the starting material has been consumed, and the peroxide radicals, as well as other radicals decompose into secondary oxidation by-products such as esters, short chain fatty acids, polymers, alcohols, ketones and aldehydes. It is these secondary oxidation by-products, which can negatively affect the growth and performance of animals.

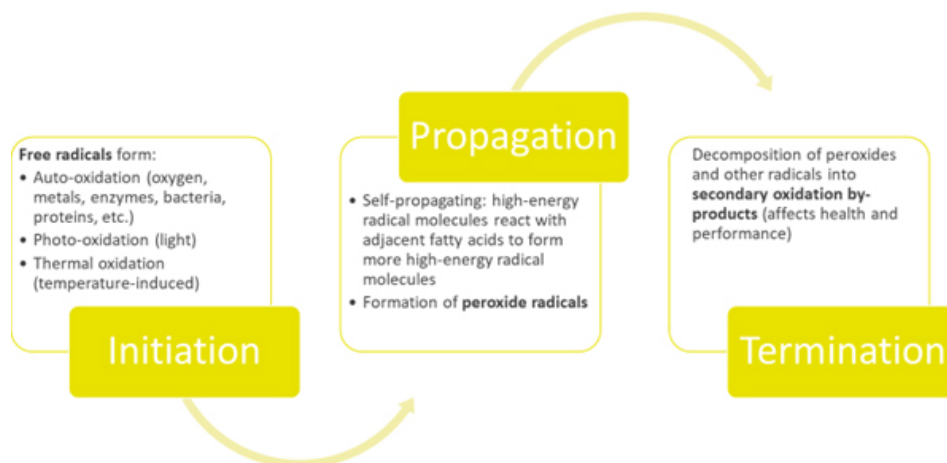


Fig. 1: Oxidation: a three-phase series of reactions

Antioxidants preserve the quality of rendered products

Chemical antioxidants are used in the rendering industry to help preserve the quality of animal by-products. Synthetic antioxidants, such as BHA, BHT, and ethoxyquin, can help prevent the oxidation of these by-products, which can cause them to become rancid. These chemical antioxidants are added in small amounts to the raw materials prior to rendering or can be incorporated into the finished products to help extend their shelf life and maintain their nutritional value. It is important to note that the use of

antioxidants in the rendering industry must be done in compliance with regulations and guidelines set forth by the FDA and other governing bodies.

Natural antioxidants like tocopherols, rosemary extract, ascorbyl palmitate, etc. are also used to prevent oxidation and maintain the freshness of rendered products, if the chemical antioxidants cannot be used.

Rancidity testing

Rancidity testing is the process of determining the level of rancidity in a product. Testing for level of rancidity is used widely as an indication of product quality and stability.

There are several methods used for rancidity testing, including:

Organoleptic rancidity testing

Oxidation of fats and oils leads to a change in taste, smell, and appearance. Organoleptic testing involves using the senses (sight, smell, taste) to determine the level of rancidity. Trained testers will examine the product for visual signs of spoilage, such as discoloration or the presence of crystals, and will also smell and taste the product to detect any off-flavors or odors.

Chemical & instrumental rancidity testing

Chemical testing involves using chemical methods to measure the level of rancidity. One common method is the peroxide value test, which measures the amount of peroxides (indicators of rancidity) in the product. Another method is the p-anisidine test, which measures the level of aldehydes (another indicator of rancidity) in the product.

Peroxide value

Peroxide Value (PV) testing determines the amount of peroxides in the lipid portion of a sample through an iodine titration reaction targeting peroxide formations. Peroxides are the initial indicators of lipid oxidation and react further to produce secondary products such as aldehydes. Because peroxide formation increases rapidly during the early stages of rancidification but subsequently diminishes over time, it is best to pair PV testing with p-Anisidine Value to obtain a fuller picture of product quality.

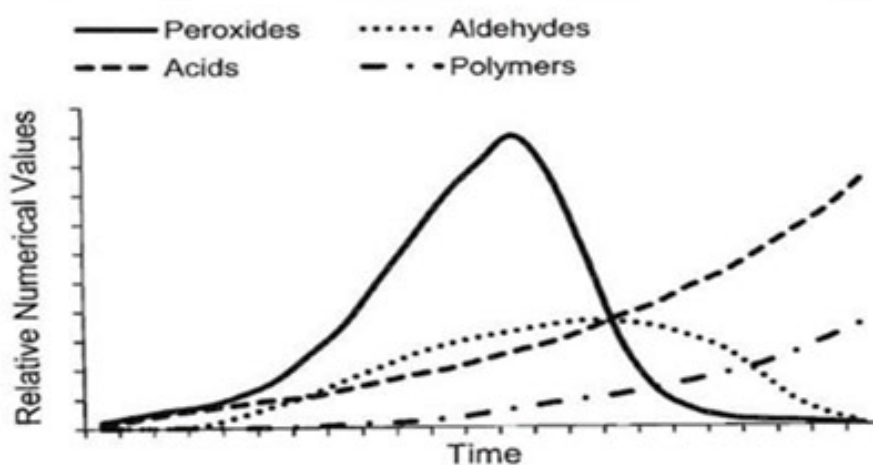


Fig.2: Oxidation products changes with time

p-Anisidine (p-AV)

p-AV is a determination of the amount of reactive aldehydes and ketones in the lipid portion of a sample. Both compounds can produce strong objectionable flavors and odors at relatively low levels. The compound used for this analysis (p-Anisidine) reacts readily with aldehydes and ketones and the reaction product can be measured using a colorimeter. Samples that are particularly dark may not be the most applicable for this analysis as the colorimeter may not be able to adequately measure the wavelength required.

TBARS

Thiobarbituric acid reactive substances (TBARS) are a byproduct of lipid peroxidation (i.e. as degradation products of fats). This can be detected by the TBARS assay using thiobarbituric acid as a reagent. TBA Rancidity (TBA) also measures aldehydes (primarily malondialdehyde) created during the oxidation of lipids. This analysis is primarily useful for low-fat samples, as the whole sample can be analyzed rather than just the extracted lipids.

The Instrumental testing involves using instruments to measure the level of rancidity.

Gas chromatography

One common method is the use of a gas chromatograph, which can detect the presence of volatile compounds that indicate rancidity.

Fourier-transform infrared spectrophotometer (FTIR)

FTIR method can detect changes in the chemical makeup of the product that indicate rancidity.

Free Fatty Acids (FFA)

FFA testing determines the fatty acids that have been liberated from their triglyceride structure. A titration is performed on the extracted fat from a specific sample. The FFA content is then determined through a calculation of the amount of titrant used to reach the final result. Knowing what type of fat or fat containing product is being tested is important for this analysis to ensure that the appropriate calculation is applied. As the test does not differentiate between fatty acid types, samples with high palmitic or lauric fatty acid composition should have a different calculation factor applied so as to accurately represent the free fatty acid result.

Oxidative Stability Index (OSI)

OSI indicates how resistant a sample is to oxidation. Samples are subjected to heat while air is injected – a process which accelerates oxidation reactions. The samples are monitored, and the time required for the sample to reach an inflection point is determined. This test is useful when testing the efficacy of an antioxidant added to a product. Antioxidants should inhibit free radical propagation and thus increase a samples ability to hold up under the stressing conditions imposed by the OSI analysis. The measuring instrument, the Rancimat.

Analytical testing considerations in rendering operations

It is common to perform regular analytical testing in a rendering operation as a part of quality control and quality assurance program. There are several methods for testing rancidity in rendering operations. It is important to choose the appropriate method based on the type of product and the desired level of accuracy.

The results of rancidity testing are used to monitor and control the rendering process to prevent or minimize rancidity. This may involve adjusting processing conditions, using antioxidants, or implementing other measures to reduce oxidation.

Test objective	Analysis	Remarks
Current state of oxidation	1. Peroxide Value (PV) 2. Secondary Oxidatives (p-Anisidine, TBARS)	1. PV:< 5 meq/kg 2. 50 ppm
Potential for future oxidation	Oxidative Stability Index (OSI)	Analyze the stability of oil/fats
Residual antioxidant	Gas chromatography	Value decreases as the antioxidant gets sacrificed

Table. 1: Analytical testing considerations for rendering

Conclusion

Rancidity is a common problem in rendered animal products. It can have detrimental effects on both the quality and safety of the product. It is caused by the oxidation of fats and oils, leading to the formation of harmful compounds such as free radicals and hydroperoxides. The best way to prevent rancidity is through proper storage, packaging, and handling techniques, as well as the use of [antioxidants](#) to slow down the oxidation process. It is important for manufacturers and consumers to be aware of the potential for rancidity in rendered animal products and take the necessary precautions to ensure the safety and quality of the product.

IgY supports calves against rotavirus infections



By **Kouji Umeda**, Production Director, EW Nutrition Japan

Calves are susceptible to infection by pathogens due to their immature congenital immunity. Bovine rotavirus and bovine coronavirus, pathogenic *E. coli*, Clostridium, Cryptosporidium, and Eimeria spp are the major pathogens of infectious diarrhea in calves less than one month of age. Bovine rotavirus, the most frequently detected in dairy and beef cattle, is responsible for approximately 40% of diarrhea cases. In addition, 60-70% of cases of diarrhea involving bovine rotavirus occur within the first two weeks of life. Symptoms include fever, anorexia, loss of energy, and acute yellow-white watery diarrhea after 12 to 36 hours post infection, which leads to dehydration and metabolic acidosis. In more severe cases, the disease can lead to death and is considered one of the most severe diarrhea-causing pathogens in newborn calves worldwide.

Rotavirus A is a major causative pathogen of diarrhea in calf

Rotaviruses belong to the family of Reoviridae and are classified into species A to J. The rotaviruses in bovines mainly belong to species A, B, and C, which are the leading infectious agents in cattle. Calf diarrhea is primarily caused by rotavirus A (RVA). This virus is transmitted orally through feces, bedding, utensils, or people contaminated with feces. Significant diarrhea caused by the virus is attributed to

- malabsorption due to the destruction of small intestinal epithelial cells and
- inhibition of water reabsorption by enterotoxin (NSP4) produced by rotaviruses.

Adult cattle and other host animals have an immune system that protects them from infection and the development of various pathogens. As RVA exists in different genotypes, the antibodies must be specifically against this genotype; otherwise, the virus-neutralizing activity, as well as protection against infection and pathogenesis, is significantly reduced.

The classic method to prevent RVA infection

Besides adequate sanitation in the production facilities, farmers try to “improve” the composition of the maternal colostrum by vaccinating the cow. For this purpose, the cows are inoculated with inactivated, previously isolated bovine RVA. However, the immunization of calves through colostrum may not be effective enough. It also may be difficult to prevent the spread of bovine RVA by barn hygiene alone due to the recent increase in the number of cattle being raised and moved from one farm to another.

Calf diarrhea feces contain G and P genotypes of bovine RVA

In general, the three most common G genotypes of bovine RVA detected in calf diarrhea are G6, G8, and G10, and the three most common P genotypes are P[1], P[5], and P[11]. Based on the results of the genotyping survey in Japan from 1987 to 2000 (Fig. 1) and the one from 2017 to 2020 (figure 2) (Animal Health Research Division of the National Institute of Agrobiological Sciences (NIAH) together with IRIG), the bovine RVA genotypes identified as prevalent and endemic in Japan in recent years were G6P[5], G6P[11], and G10P[11]. However, the percentage of genotypes detected differed among cattle breeds (Fig. 3A, Fig. 3B, Fig. 3C).

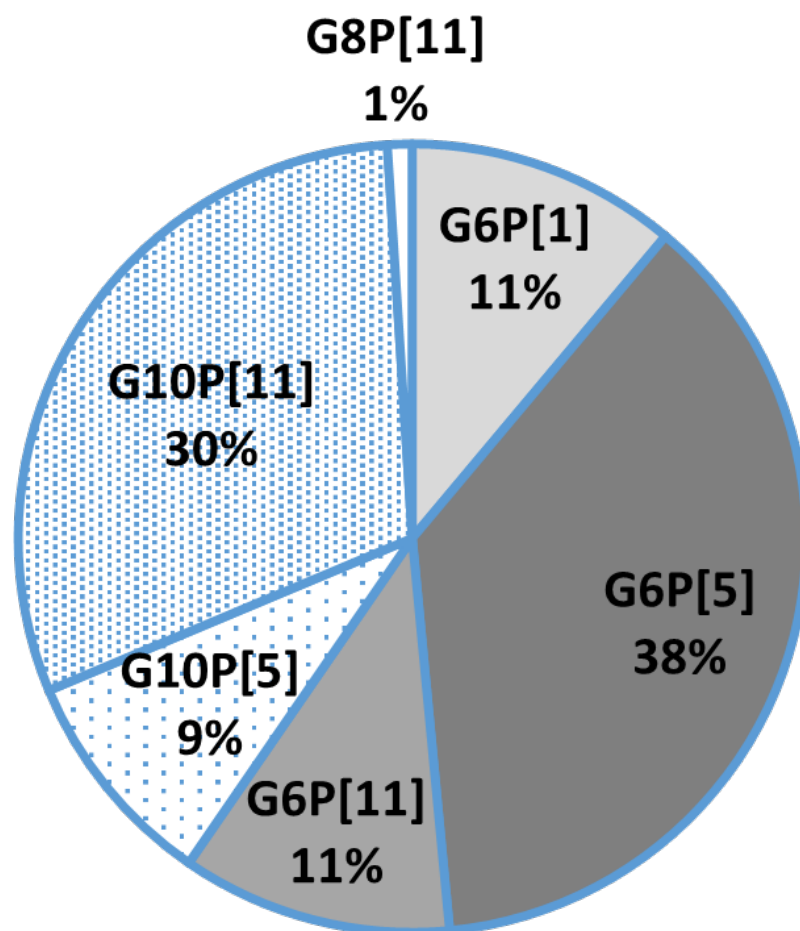


Fig.1: Genotyping results from 1987-2000

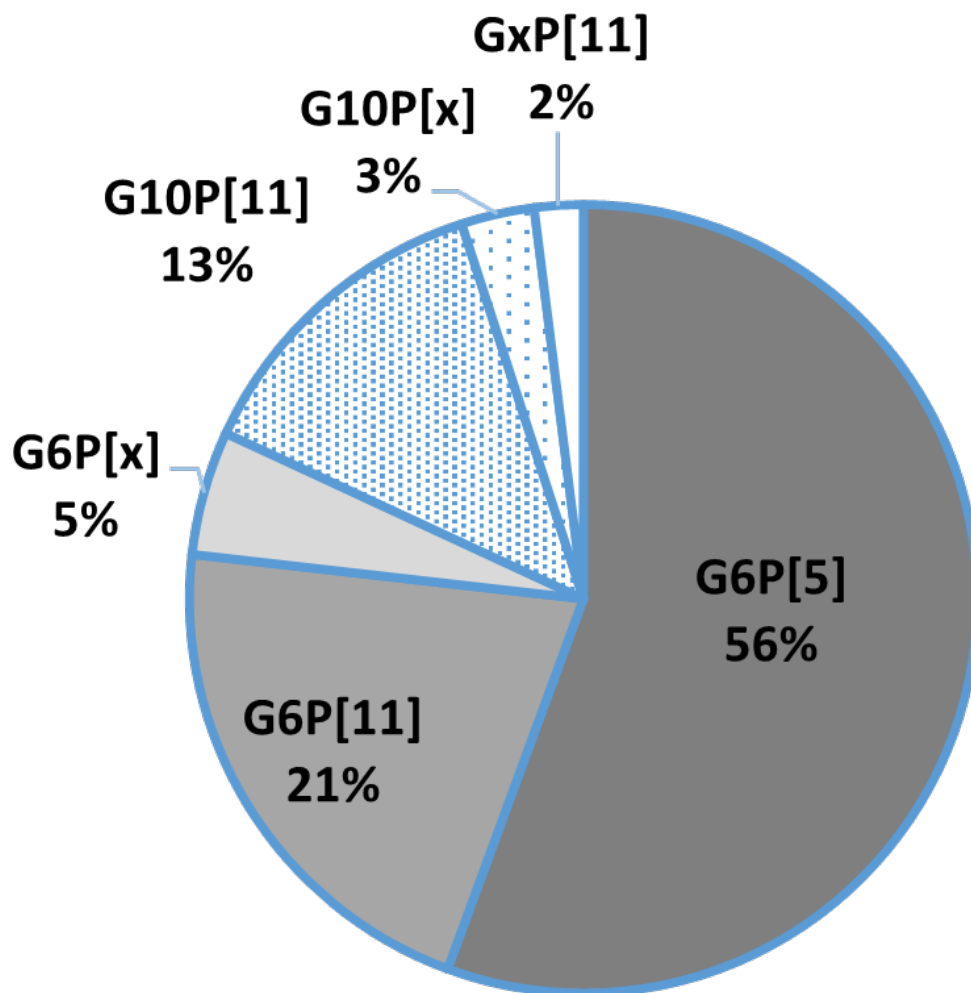
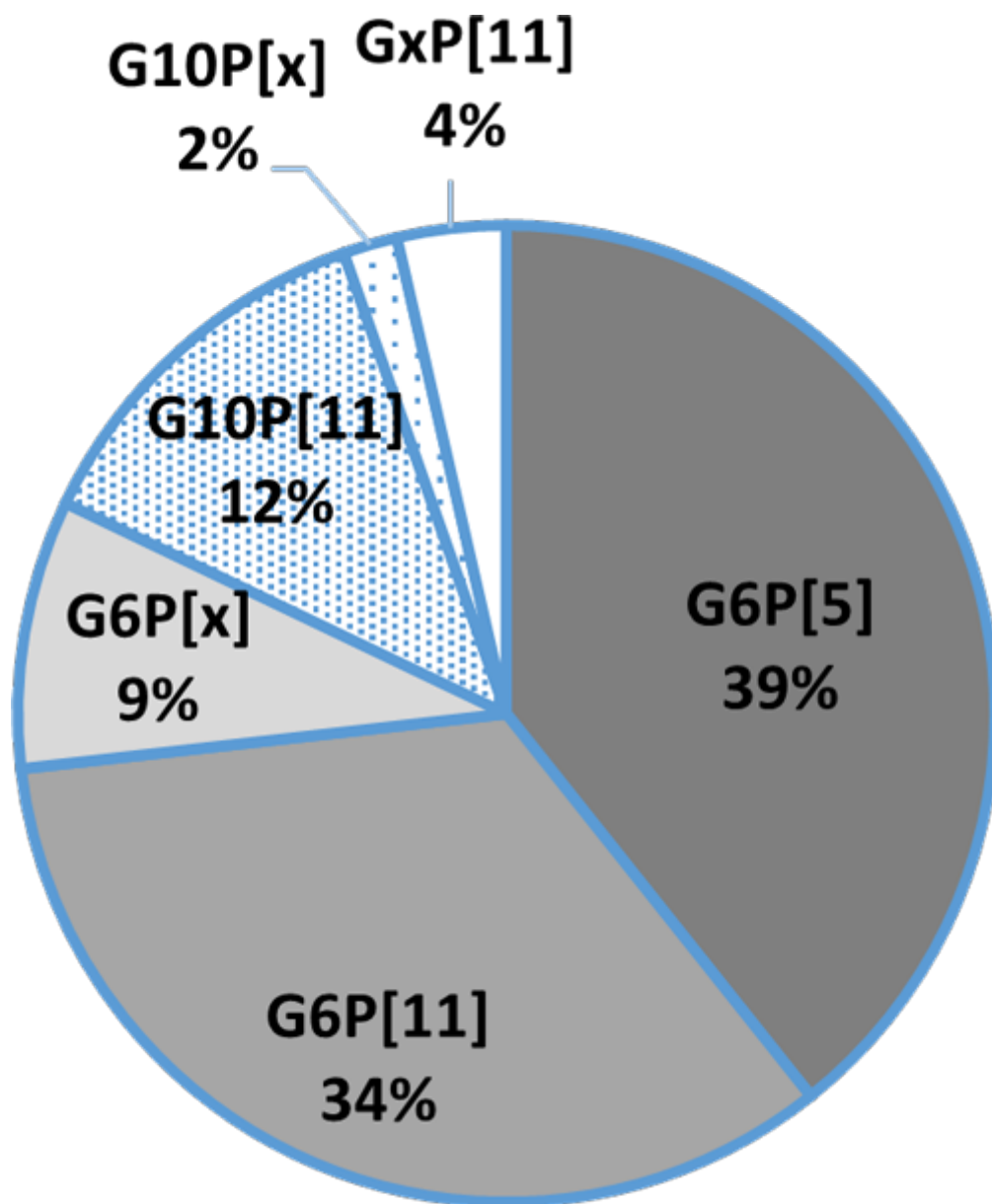
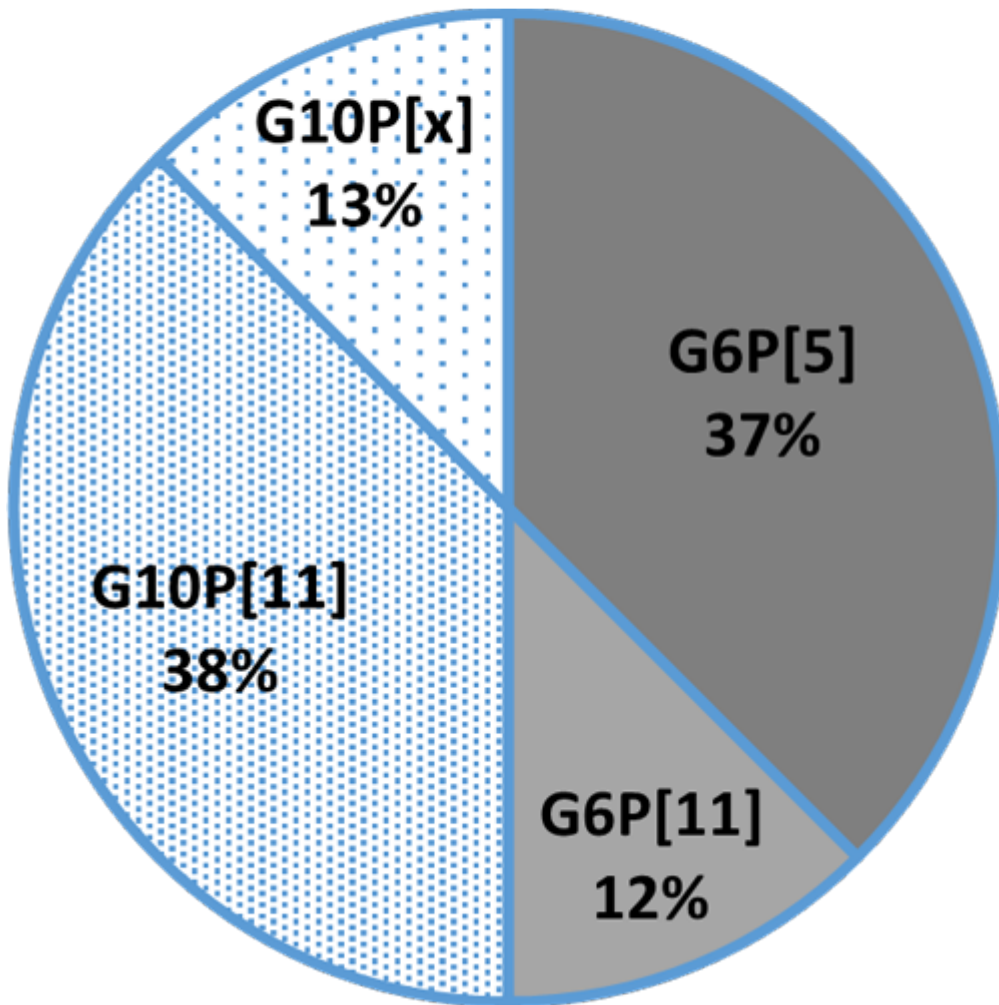


Fig.2: Genotyping results from 2017-2020



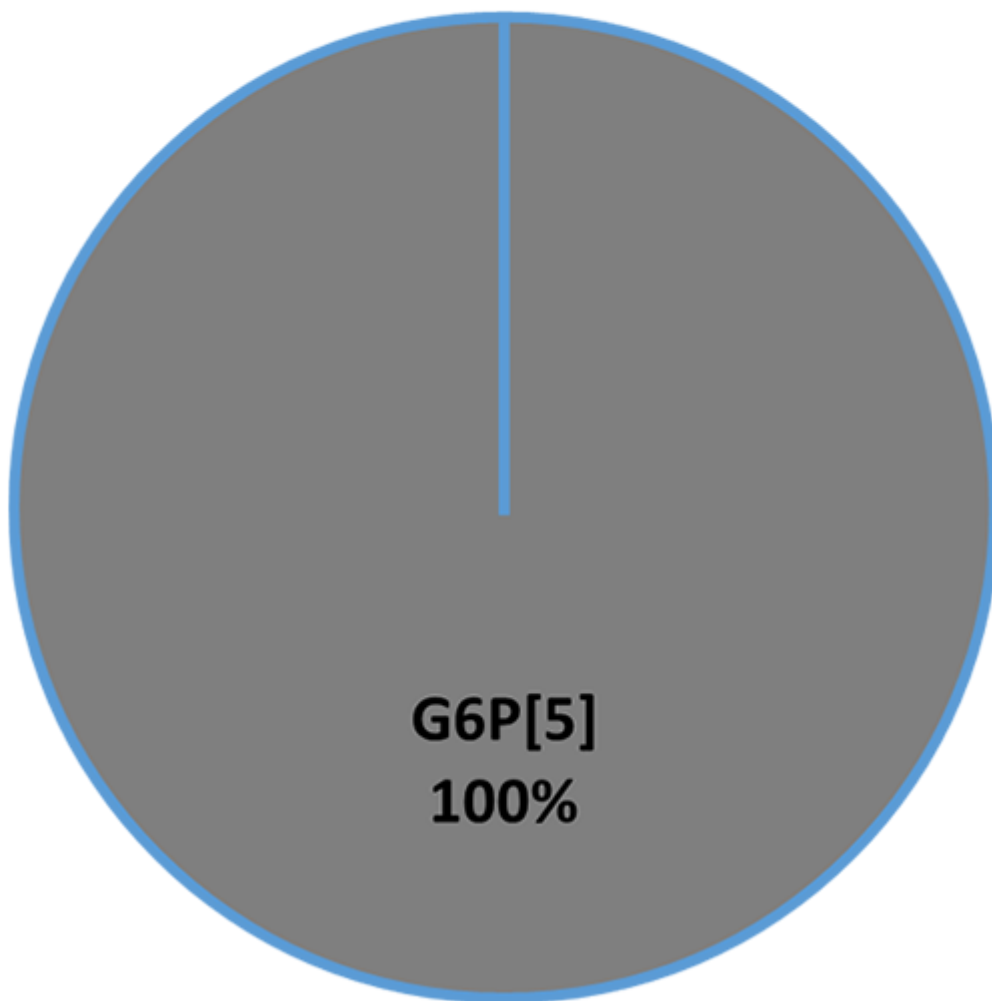
detection in Holstein

Fig. 3A:Percentage of



crossbreeds

Fig. 3B: Detection rate in



*Fig. 3C: Detection rate in
beef cattle (Wagyu)*

Cow colostrum protects the calf, egg yolk the chick AND the calf

A cow provides the calf with colostrum to ensure immunoglobulin delivery (passive immunity). In poultry, hens transfer immunoglobulins to the egg yolks and pass immunoglobulins to their chicks in this way. This biological mechanism of “immune transfer to the egg yolk” in birds can be used to arbitrarily produce yolk immunoglobulin (IgY) against pathogens of enteric infections in livestock ([Ikemori et al., 1992](#); [Ikemori et al., 1997](#); [Yokoyama et al., 1998](#)).



For this purpose, hens must get in contact with the respective pathogens. They produce antibodies against these pathogens – which also works with non-poultry-relevant pathogens such as bovine RVA – and transfer them to the egg (⇒IgY). The eggs with accumulated high levels of useful IgY can be collected almost daily. The immunoglobulins can be fed to livestock animals such as calves to protect them in critical times.

Continuous feeding of milk formulas containing IgY allows the IgY to remain in the intestinal lumen for a long time ([Nozaki et al., 2019](#)). There, they bind to the target pathogens and prevent infection by inhibiting their attachment to and cell invasion into intestinal epithelial cells.

IgY and genotype of the virus must match

A study verified that anti-bovine RVA IgY consisting of anti-G6P[1], anti-G6P[5], and anti-G10P[11] shows broad-spectrum virus-neutralizing activity against recent field isolates. Separate trials (see table 1) demonstrated that anti-G6 genotype IgY acted best against the RVA genotypes G6P[1] and G6P[5] and showed less activity against the G10 genotype. Anti-G10P[11] IgY worked optimally against the P[11] genotypes. The trials confirmed that either the G or the P genotype must match to achieve a sufficient virus-neutralizing activity. The IgY mixture is not helpful against bovine RVA strains that match neither the G nor the P genotypes ([Odagiri et., 2020](#)).

As the genotyping survey of 2017-2020 showed mainly G6 and G10 genotypes, a mixture of anti- bovine RVA G6P[1] IgY, G6P[5], and G10P[11] has strong virus neutralizing activity against bovine RVA that is currently prevalent and spreading in production sites.

Table 1: Virus-neutralizing activity of field-isolated bovine RVA against various genotypic strains

IgY	Virus-neutralizing test strain									
	SMN 1	HKD 18	SMN 35	HKD 6	HKD 7	HKD 17	KK-3	OKY 31	MYG 1	Dai-10
	1978	2018	2018	2017	2017	2017	1983	2017	2017	2007
	G6P[1]	G6P[5]	G6P[5]	G6P[11]	G6P[11]	G6P[11]	G10P[11]	G10P[11]	G8P[14]	G24P[33]
anti-G6P[1] 1978 IgY	+++	+++	+++	+++	+++	+++	+	+	-	-
anti-G6P[5] 2018 IgY	+++	+++	+++	++	++	++	+	+	+	-
Anti-G10P[11] 2017 IgY	+	+	+	+	++	++	+++	+++	-	-

Control IgY	-	-	-	-	-	-	-	-	-	-
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+++ Strong virus neutralizing activity; ++ Moderate virus neutralizing activity; + Weak virus neutralizing activity; No virus neutralizing activity

Anti-bovine RVA IgY supports calves against rotavirus infection

To verify the protective effect of oral passive immunization with anti-bovine RVA IgY against bovine RVA infection, a trial with newborn calves was conducted.

Trial design: Eight calves were separated from their mothers immediately after birth without feeding colostrum and moved to a house with infected animals. From the first day, the calves were fed artificial milk supplemented with anti-bovine RVA IgY (n=4) or non-immune IgY (Control IgY; n=4) three times a day.

The parameters observed were fecal score, bovine RVA excretion, and weight gain; data were collected daily. The fecal score was calculated as the cumulative fecal score during the study period: 0 for normal stools, 1 for soft to muddy stools, and 2 for watery stools. Bovine RVA was isolated from daily fecal samples and evaluated by the total number of days of bovine RVA excretion.

Results: The anti-bovine RVA IgY group was found to be effective in reducing the incidence of diarrhea and shortening the duration of virus excretion in the infection test with the bovine RVA G6 genotype strain and the bovine RVA G10 genotype strain (tables 2 and 3).

Table 2: Efficacy of anti-bovine RVA IgY feeding in bovine RVA G6 genotype strain infection

Test Group	Diarrhea incidence (n animals affected/n animals tested)	Cumulative fecal score	Bovine RVA excretion days	Increase in body weight	
				kg	%
Anti-bovine RVA IgY	0% (0/4)	0.0 ± 0.0*	2.3 ± 0.5**	1.3 ± 0.4**	3.5 ± 0.7**
Control IgY	100% (4/4)	12.8 ± 4.8	7.8 ± 1.3	- 3.3 ± 1.6	- 7.6 ± 3.6

** P<0.01; * P<0.05

Table 3: Efficacy of anti-bovine RVA IgY feeding in bovine RVA G10 genotype strain infection

Test Group	Diarrhea incidence (n animals affected/n animals tested)	Cumulative fecal score	Bovine RVA excretion days	increase in body weight	
				kg	%
Anti-bovine RVA IgY	50% (2/4)	2.3 ± 4.5**	4.3 ± 1.3**	1.1 ± 0.8**	3.3 ± 3.1**
Control IgY	100% (4/4)	14.5 ± 3.7	7.3 ± 1.0	- 4.2 ± 0.7	- 11.1 ± 2.1

** P<0.001

IgY is a valuable tool in rotavirus control

Newborn calves, susceptible to severe diarrhea caused by bovine RVA infection, require passive immunization with antibodies transferred from the colostrum of the mother cow. However, sometimes, calves don't get enough antibodies which can be the case if

- the calf does not receive enough colostrum or receives it too late
- the cow still has not the farm-specific antibodies because of a too short time of being on the farm

To compensate for this lack of immunity, calves have been fed milk formulas containing anti-bovine RVA IgY for some time. Continuous feeding of anti-bovine RVA IgY, which shows strong virus neutralizing activity against each genotype of bovine RVA isolated from recent cases of calf diarrhea, is expected to provide sufficient immunity and be an effective means of bovine RVA control.

In the case of disease outbreaks, it makes sense to utilize IgY with appropriate mechanisms of action in addition to improving the level of quarantine measures, including hygiene control and vaccination.

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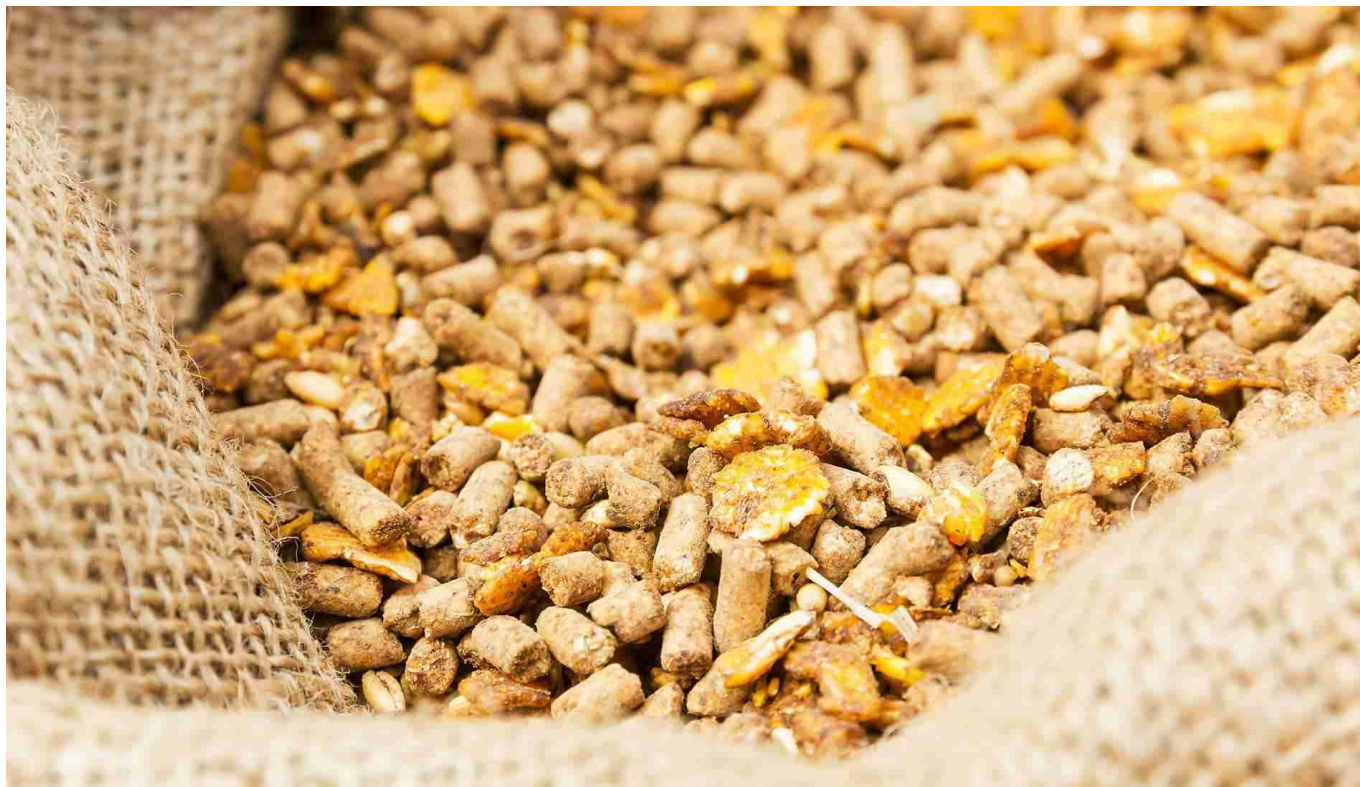
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Effective phytomolecules combine superior processing stability and strong action in the animal



By **Dr. Inge Heinzl**, Editor, and **Dr. Ruturaj Patil**, Global Product Manager – Phytogenics, EW Nutrition

For millennia, plants have been used for medicinal purposes in human and veterinary medicine and as spices in the kitchen. Since the ban of antibiotic growth promoters in 2006 by the European Union, they also came into focus in animal nutrition. Due to their digestive, antimicrobial, and gut health-promoting characteristics, they seemed an ideal alternative to compensate for the reduced use of antibiotics in critical periods such as brooding, feed change or gut-related stress.

To optimize the benefits of phytomolecules, it is crucial that

- the phytomolecules levels are standardized for consistent results and synergy
- they show the highest stability during stringent feed processing; being often highly volatile substances, they should not get lost at high temperatures and pressure
- the phytomolecules are preferably completely released and available in the animal to achieve the best effectiveness.

First step: Standardized phytomolecules

Essential oils and other phytogenics are sourced from plants. The [composition of the plants substantially depends](#) on genetic dissimilarity within accessions, plant origin, the site conditions, such as weather, soil, community, and harvest time, but also sample drying, storage, and extraction processes (Sadeh et al., 2019; Yang et al., 2018; Ehrlinger, 2007). For example, the oil extracted from thyme can contain between 22 and 71 % of the relevant phenol [thymol](#) (Soković et al., 2009; Shabnum and Wagay, 2011; Kowalczyk et al., 2020).

Modern technology enables the production of standardized phytomolecules with the highest degree of purity and lowest possible batch-to-batch variation for high-quality products. It also offers increased environmental and economic sustainability due to reliable and cost-effective sourcing technology.

Using such [highly standardized phytomolecules](#) enables the production of [phytogenic-based feed supplements](#) of consistently high quality.

Second step: Selection of the most suitable phytomolecules

Phytomolecules have different primary characteristics. Some support [digestion](#) (Cho et al., 2006, Oetting, 2006; Hernandez, 2004); others [act against pathogens](#) (Sienkiewicz et al., 2013; Smith-Palmer et al., 1998; Özer et al., 2007) or are [antioxidants](#) (Wei and Shibamoto, 2007; Cuppett and Hall, 1998). To optimize gut

health in animal production, one of the main promising mechanisms is reducing pathogens while promoting beneficial microbes. The decrease of pathogens in the gut not only decreases the risk of enteritis incidence but also eliminates the inconvenient competitors for feed.

In order to find out the best combination serving the intended purpose, a high number of different phytomolecules need to be evaluated concerning their structure, chemical properties, and biological activities first. Availability and costs of the substances are further factors to consider. With the selection of the most suitable phytomolecules, different mixtures are produced and tested for their effectiveness. Here, it is essential to concern synergistic or antagonistic effects.

For an effective and efficient blend of phytomolecules, many steps of selection and tests are necessary – and as a result, possibly only a few mixtures can meet the requirements.

Third step: Protecting the ingredients

Many phytomolecules are inherently highly volatile. So, only having a standardized content of phytogenics in the product can not ensure the full availability of phytomolecules when used through animal feed. Some parts of the ingredients might already get lost in the feed mill due to the stringent feed hygienization process followed by feed millers to reduce pathogenic load. The heating is a significant challenge for the highly-volatile components in a phytomolecule-based product. So, protecting these phytomolecules becomes imperative to guarantee that the phytomolecules put into the feed will reach the animal.

A delicate balancing act is required to ensure the availability and activity of phytomolecules at the right site in the gut. The phytomolecules must not get lost during feed processing but must also be released in the intestine. A carrier with capillary binding of the phytomolecules together with a protective coating can be one of the available effective solutions. It protects the ingredients during feed processing, and ensures the release in the animal.

Study shows excellent stability of Ventar D under challenging conditions

[Ventar D](#) is a latest generation phytomolecule-based solution for gut health optimization introduced by EW Nutrition, GmbH. A scientific study was conducted to compare the stability of Ventar D, in the pelleting process, with two leading phytogenics competitor feed supplements.

For this trial, feed with the different added phytogenic feed supplements had to undergo a conditioning and pelletization process. The active ingredients were analyzed before and after the pelletization process. All phytogenic feed supplements under testing were added to standard broiler feed at the producer's recommended inclusion rate. The tests took place under conditioning times of 45, 90, and 180 seconds and pelleting temperatures of 70, 80, and 90°C (158, 176, and 194°F). After cooling, triplicate samples were collected and analyzed. The respective marker substance was analyzed through gas chromatography/mass spectrometry (GC/MS) analysis to measure the recovery rate in the finished feed. The phytomolecule content of the mash feed (before pelletization) found by the laboratory was used as a baseline and set to 100% recovery. The recovery rates of the pelleted feed were evaluated relative to this baseline.

The results are presented in figure 1. Ventar D showed the highest stability of active ingredients with recovery rates of 90% at 70°C/45 sec. or 80°C/90 sec and 84% at 90°C/180 sec. The modern production technology used for Ventar D ensures that the active ingredients are well protected throughout the pelletization process.

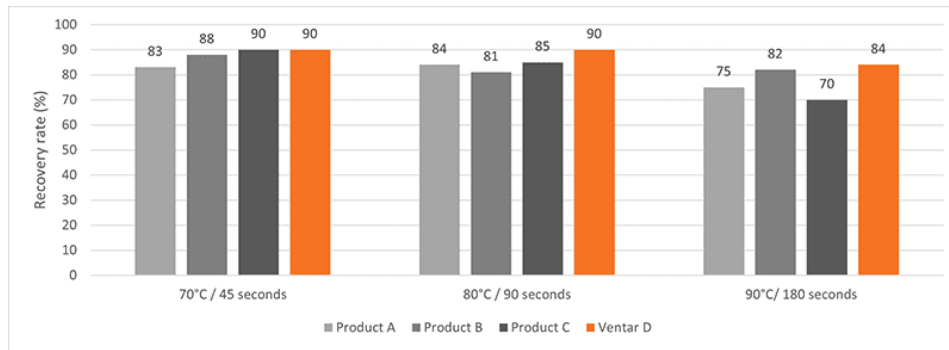


Figure 1: Phytomolecule stability under processing conditions, relative to mash baseline (100%)

Another trial was conducted in a feed mill in the US. For this trial, ten samples were collected from different batches of mash feed where Ventar D was added at 110g/t. Conditioning of the mash feed was at 87.8°C (190°F) for 6 minutes and 45 seconds. After the pelleting process, ten samples from the pelleted feed were collected from the continuous flow with a 5 min gap between the samplings to determine Ventar D's recovery.

The average recovery achieved for Ventar D was 92%.

Trials show improved growth performance

Initial trials showed Ventar D's complete release in digestion models. To examine the benefit in in-vivo conditions, Ventar D was tested in broilers at an inclusion rate of 100 g/MT.

Several in vitro studies proved the antimicrobial activity of Ventar D. One test also confirms that Ventar D could exhibit differential antimicrobial activity by having [stronger activity against common enteropathogenic bacteria while sparing the beneficial ones](#) (Heinzl, 2022). Moreover, Ventar D's antioxidant and anti-inflammatory activity support better gut barrier functioning. Better gut health leads to higher growth performance and improved feed conversion, which could be demonstrated in several trials with broilers (figures 2 and 3). In the tests, a group fed Ventar D was compared to either a control group with no such feed supplement or groups supplied with competitor products at the recommended inclusion rates.

Compared to a negative control group, the Ventar D group consistently showed a higher average daily gain of 0.3-4.1 g (0.5-8.5 %) and a 3-4 points better feed conversion. Compared to competitor products, Ventar D provided 1-1.7 g (2-3 %) higher average daily gain and a 3 points better /1 point higher FCR than competitors 2 and 1.

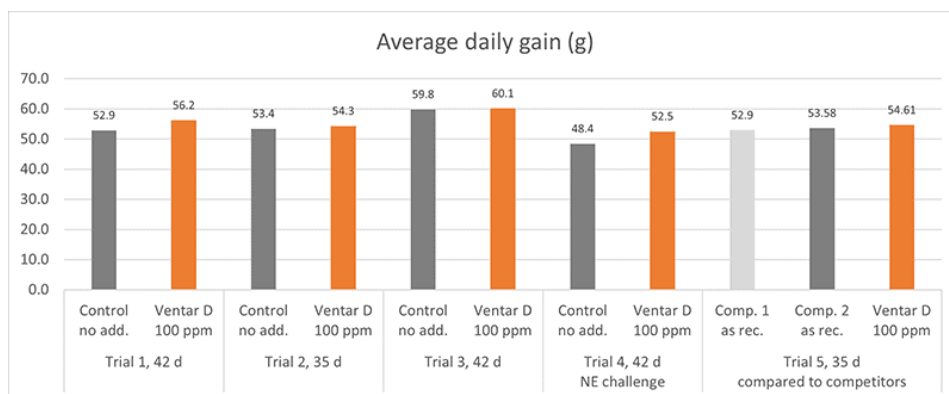


Figure 2: Average daily gain (g) – results of several trials conducted with broilers

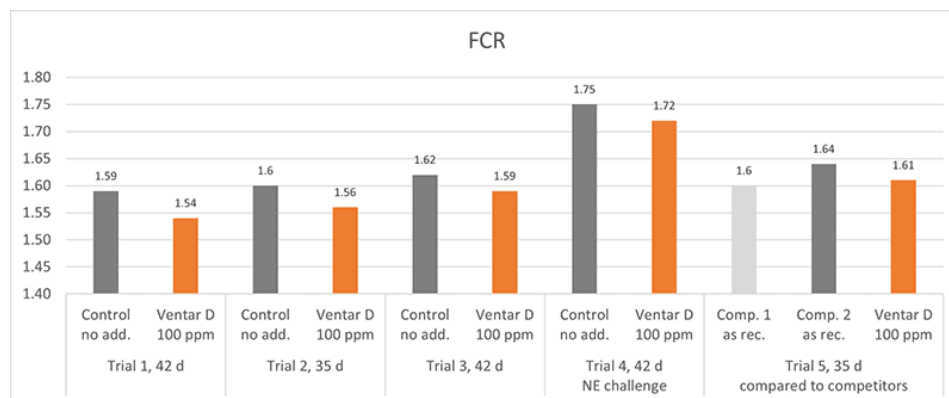


Figure 3: FCR – results of several trials conducted with broilers

Standardization and new technologies for higher profitability

Several in vitro and in vivo studies proved that Ventar D takes “phytomolecules’ power” to the next level: Combining standardized phytomolecules and optimal active ingredient protection leads to superior product stability during feed processing. The higher amount of active ingredients arriving in the gut improves gut health and increases the production performance of the animals. Ventar D shows how we can use phytomolecules more effectively and benefit from higher farm profitability.

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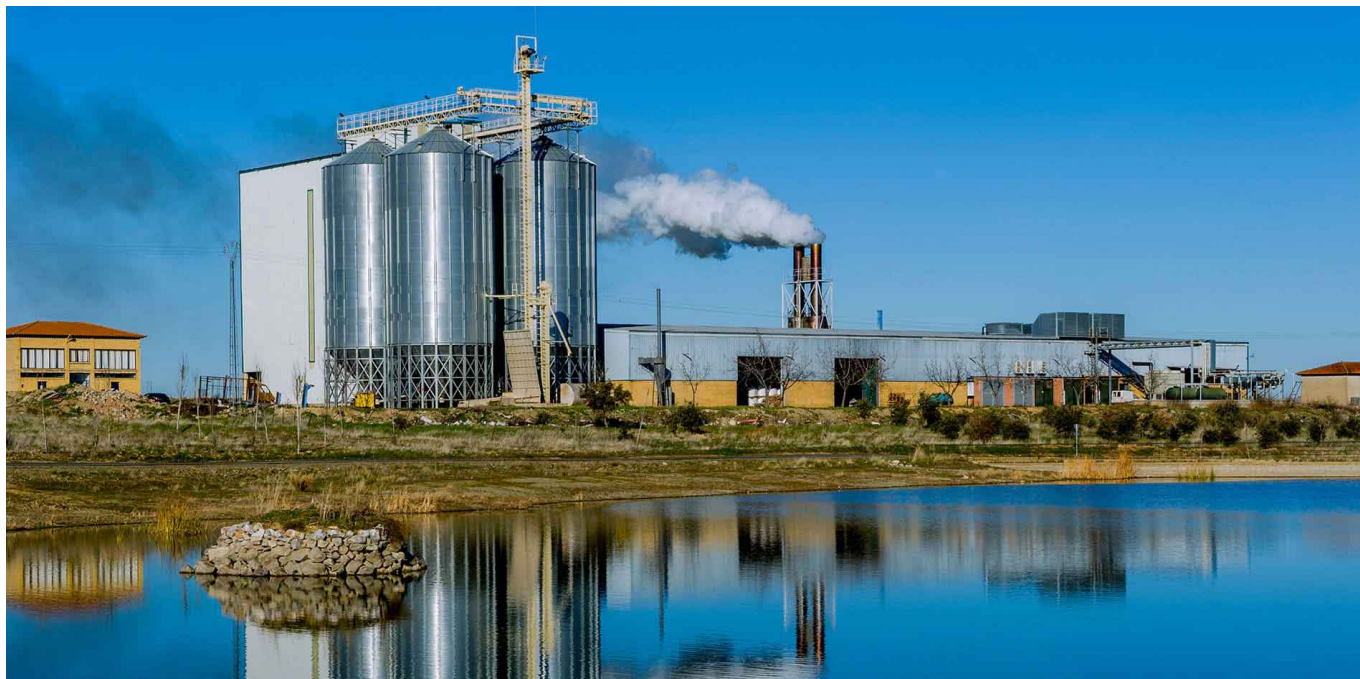
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**Feed processing is the
sustainability champion no one
knows about (yet!)**



By **Predrag Persak**, Regional Technical Manager Europe, EW Nutrition

Imagine you're at a pub quiz dedicated to feed production, and this question pops up: name a process that returns up to 25 times what was invested in it. Do you know the answer? I'm pretty sure you are probably using it every day: pelleting. For every unit of used energy, pelleting generates up to 25 times more in terms of the nutritional value for animals (mostly metabolizable energy).

The math is simple: while we gain 200 kcal/kg by pelleting broiler mash feed, only 10 Kilowatts are used to produce one ton of broiler feed. This is just one example of how sustainability is at the core of feed production – and has always been, long before it became a buzzword. So, to all those who operate feed mills, who take care of sourcing and quality, and to those behind numbers that represent nutritional values: You are pioneers of sustainability and should be proud of that.

How feed processing can drive sustainability efforts

Besides being proud, we must also be very responsible. Every nutritionist should focus on

1. how processing of feed materials and feed influences the release of nutrients, nutrient density, and exclusion of antinutrients, and
2. how processing can improve these dimensions, making feed more sustainable.

Do we take processing sufficiently into consideration? Do we create formulations in a dynamic or more static way? Not least in an era of precision feeding, the shift from static to dynamic is inevitable.

This is even clearer when we consider how processing can influence digestion, absorption, and the performance of animals. How so? Feed processing makes previously unusable materials suitable for nutrition or improves already usable materials. So, the feed processing itself is a key to sustainability.

Feed processing converts energy into more energy (!?)

Feed processing, in simple terms, means converting energy into more energy. This shouldn't work, given the law of thermodynamics, but it does. Compound feed contains various feed materials and additives. Grains and protein sources (many times wrongly declared as byproducts), fibrous roughages and many

other different components should not go together. Thanks to processing, they become feed which ensures the availability of all nutrients to the species, category, or animal production system for which that feed is intended.



Through processing, we alter the physical, chemical, and edible properties of used feed materials, making them usable for animals. Through proper processing, we improve the digestibility of feed materials by up to 20%, enabling a more effective – and thus more sustainable – use of feed resources. In practice, there is room for improvement to make feed processing even more of a sustainability champion.

Moisture optimization is key to energy-efficient pelleting

Let's take a closer look at [pelleting](#) since it requires the most energy within feed processing. How much energy is used? This depends on many factors and can range from 5 KW/h up to 25. Pelleting is mostly used in broiler diets to reduce nutrient segregation and feed sorting and, by extension, feed wastage. Pelleting has also been found to increase the weight gain of individual birds and flock uniformity, and overall feed efficiency is higher.

Pelleting involves the agglomeration of mixed feed into whole pellets through a mechanical process using heat, moisture, and pressure (Falk, 1985). Heat (energy that is transported through steam) has the largest impact on pelleting efficacy. Steam injected during conditioning increases feed moisture and temperature, softens feed particles, extracts natural binders, and reduces friction which leads to greater production rates and pellet quality (Skoch et al., 1981).

The key to an efficient pelleting process is to set the parameters at the levels that will enable proper energy transfer from steam to feed particles. Besides steam quality, the moisture of the feed is a critical factor for efficient energy transfer. Generally, the thermal conductivity of the most used feed materials increases with increasing moisture. A level of 17% moisture in the conditioner is needed for efficient energy transfer. Below 17%, we need more steam (more energy) or more time (more capacity) to achieve the same result. That is why [proper moisture optimization](#) is needed to use the energy transferred through steam in the most efficient way.

Reduce shrinkage, improve sustainability

What about shrinkage? Shrinkage is not just a [cost factor](#) but a sustainability issue. We must not lose scarce and valuable materials and nutrients. Overall shrinkage tends to be around 1%. For global feed production as a whole, 1% annual shrinkage is equivalent to 15 years of Croatian compound feed

production!

We help our industry to keep up sustainability efforts in terms of energy savings and shrinkage reduction by offering [SurfAce](#). It's a liquid preservative premixture with multiple economic and environmental benefits to the customer. It helps increase pellet output, improves conditioning, enhances the durability of the pelleted feed, reduces the formation of fines, and improves the overall quality of the final feed product. But most importantly, it optimizes feed production costs through energy savings and reduced labor input while also supporting the microbiological quality of the feed.

In the food sector, we have seen vast improvements in non-thermal food processing over the past decade. Examples include ultrasonication, cold plasma technology, supercritical technology, irradiation, pulsed electric field, high hydrostatic pressure, pulsed ultraviolet technology, and ozone treatment. I'm sure some of these technologies will be applied to feed processing one day. Until then, we must keep up our high sustainability standards and make it more efficient by applying all available tools in our feed processing toolbox.

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Keep coccidiosis under control - naturally!



By **Dr. Inge Heinzl**, Editor, **Madalina Diaconu**, Product Manager Pretect D, and **Dr. Ajay Awati**, Global Category Manager Gut Health & Nutrition, EW Nutrition

Often you have an extensive coccidiosis control program in place. You don't observe any clinical signs of coccidiosis. However, at the end of the cycle, you record significantly lower body weight and a higher FCR. There is a high probability that your animals have subclinical coccidiosis. This article digs deeper into understanding why birds don't perform as they should, why subclinical coccidiosis occurs on the farm, and why drug resistance is an important factor.

Subclinical coccidiosis - a silent enemy

Clinical coccidiosis is clearly characterized by severe diarrhea, high mortality rates, reduced feed/water intake, and weight loss. By contrast, subclinical Coccidiosis does not display any visual signs and often remains undetected.

According to De Gussem (2008), the damages caused by subclinical coccidiosis can reach up to 70% of the total cost of coccidiosis control treatments, ranging from US\$ 2.3 billion to US\$ 13.8 billion/year in 2020 worldwide (De Gussem, 2008; Ferreira da Cunha, 2020; Blake et al., 2020).

Monitoring coccidiosis occurrence on the farm

There are several tools available to evaluate the level of infection. The most common ones are:

Lesion scoring - is used to evaluate the damages caused by coccidiosis in the intestinal tract. Lesion scoring gives insight into the severity of the infection. Furthermore, based on the location of lesions in the GI tract, it is possible to determine the plausible *Eimeria* spp. responsible for the infection.

OPG (Oocyst per gram) – the number of oocysts per gram of feces indicates the level of shedding of oocysts in the manure, litter, and, eventually, in the farm environment. OPG levels may not give the exact severity of the infection in the bird but certainly provide a clear idea of its likely spread within the flock.

Ways to deal with coccidiosis on the farm

Different tools are widely used to prevent and treat coccidiosis:

Anticoccidials:	Chemicals, ionophores
Vaccination:	Natural strains, attenuated strains
Bio-shuttle:	Vaccine + ionophore
Natural anticoccidials:	Phytomolecules

These coccidiosis control programs are used depending on the farm history and the severity of the infection. Traditionally, treatment was heavily dependent on chemicals and ionophores. However, rampant and unbridled use of ionophores leads to resistance in *Eimeria* spp. on the farm, the failure of the control program, and significant performance losses, with high mortality due to coccidiosis. Therefore, the tools mentioned above are inserted in rotation or shuttle programs to minimize the generation of resistances. In a rotation program, the anticoccidial changes from flock to flock. In a shuttle program, the anticoccidial changes within one cycle according to the feed (Chapman, 1997).

However, this strategy is often not 100% effective due to a lack of diversity and overuse of certain tools within programs. The rigorous financial optimization of the program leads to the use of cost-effective but marginally effective solutions. These factors over the period weaken the program, which seems to work well but leads to resistance to anticoccidial drugs and sets up subclinical coccidiosis.

Resistances have been reported in the US (Jeffers, 1974, McDougald, 1981), South America (McDougald, 1987; Kawazoe and Di Fabio, 1994), Europe (Peeters et al., 1994; Bedrník et al., 1989; Stephan et al., 1997), Asia (Lan et al., 2017; Arabkhazaeli et al., 2013), and Africa (Ojimelukwe et al., 2018). Chapman and co-workers (1997) even stated that resistances were documented for all anticoccidial drugs employed at this time, and new products have not been approved for decades.

Resistance and subclinical coccidiosis can be approached naturally

When an anticoccidial has lost its effectiveness due to excessive use, some resistant coccidia survive. They can cause a mild course of the disease, subclinical coccidiosis, driving the costs high. Reducing the occurrence of resistance and subclinical coccidiosis can significantly decrease the expenses of coccidiosis control programs and, eventually, the cost of production.

Increasing consumer pressure to reduce the overall usage of drugs in animal production has driven innovation efforts to find natural solutions that can be effectively used within coccidiosis control programs. However, this shift was not easy for the producers. Lack of reliable data, poor understanding of the mode of action, lack of quality optimization, and unsubstantiated claims led to the failure of many earlier-generation natural solutions.

However, the consumer-driven movement to find natural solutions to animal gut health issues has recently led to relentless innovation in this area. Knowledge, research, and technological developments are now ready to offer solutions that can be an effective part of the coccidia control program and open opportunities to make poultry production even more sustainable by reducing drug dependency.

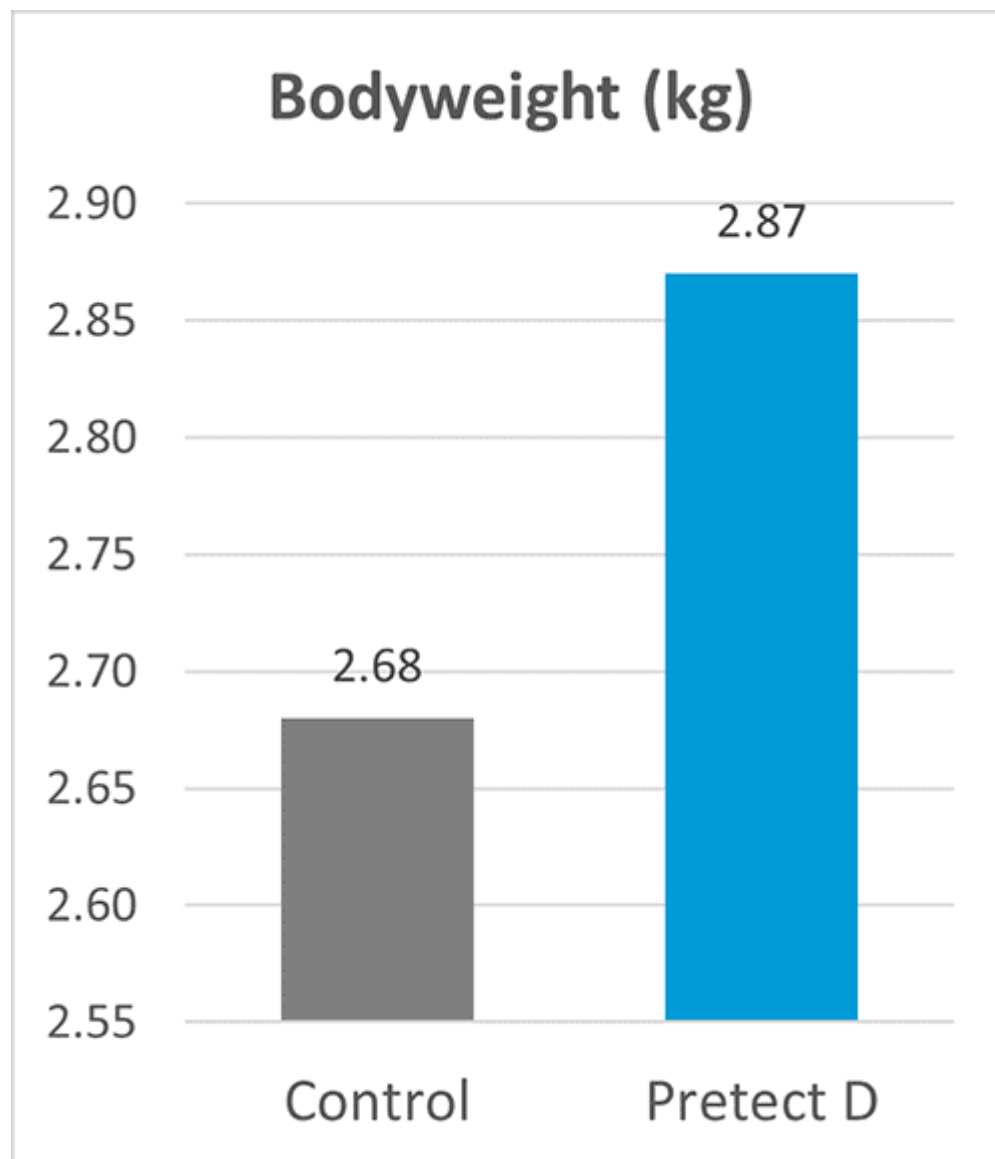
For centuries, phytomolecules have been used for their medicinal properties and effects on the health and well-being of animals and humans. In the case of coccidiosis, tannins and saponins have been proven to support animals in coping with this disease. Tannic acids and tannic acid extracts strengthen the intestinal

barrier by reducing oxidative stress and inflammation (Tonda et al., 2018). On the other hand, saponins lessen the shedding of oocysts, improve the lesion score, and, in the case of an acute infection, the occurrence of bloody diarrhea (Youssef et al., 2021).

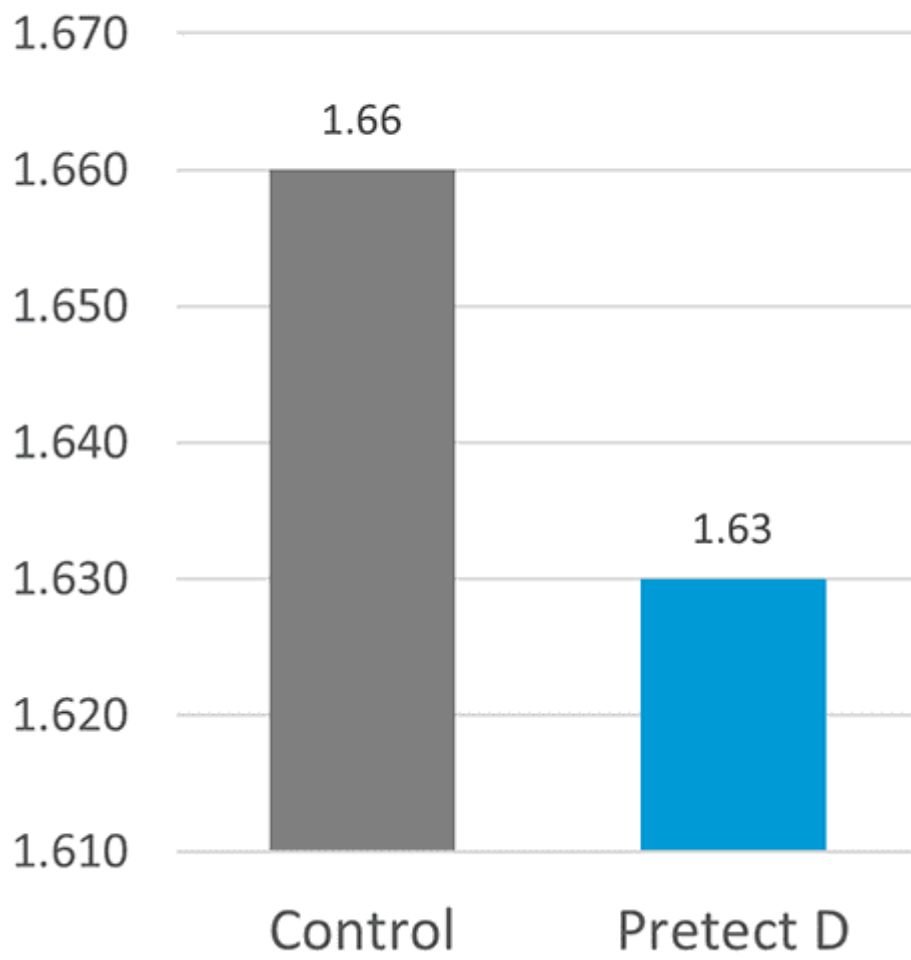
These natural substances can be integrated into shuttle or rotation programs to reduce the use of anticoccidials and, therefore, minimize resistance development.

Pretect D: Coccidiosis programs can be strengthened naturally!

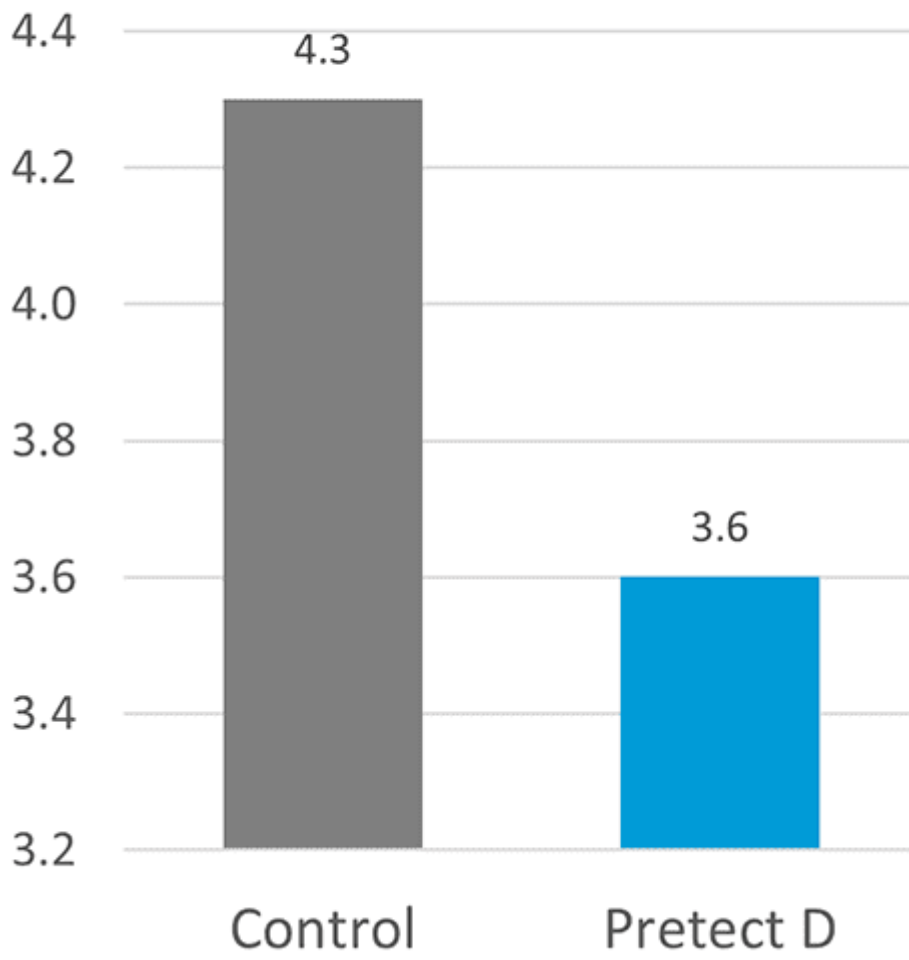
In an EU field trial conducted with more than 200 000 birds, [Pretect D](#) (a natural phytogetic-based product designed to increase the efficacy of coccidiosis control) was used in the shuttle program together with ionophores. The trial provided excellent results on zootechnical performance (figures 1-4).

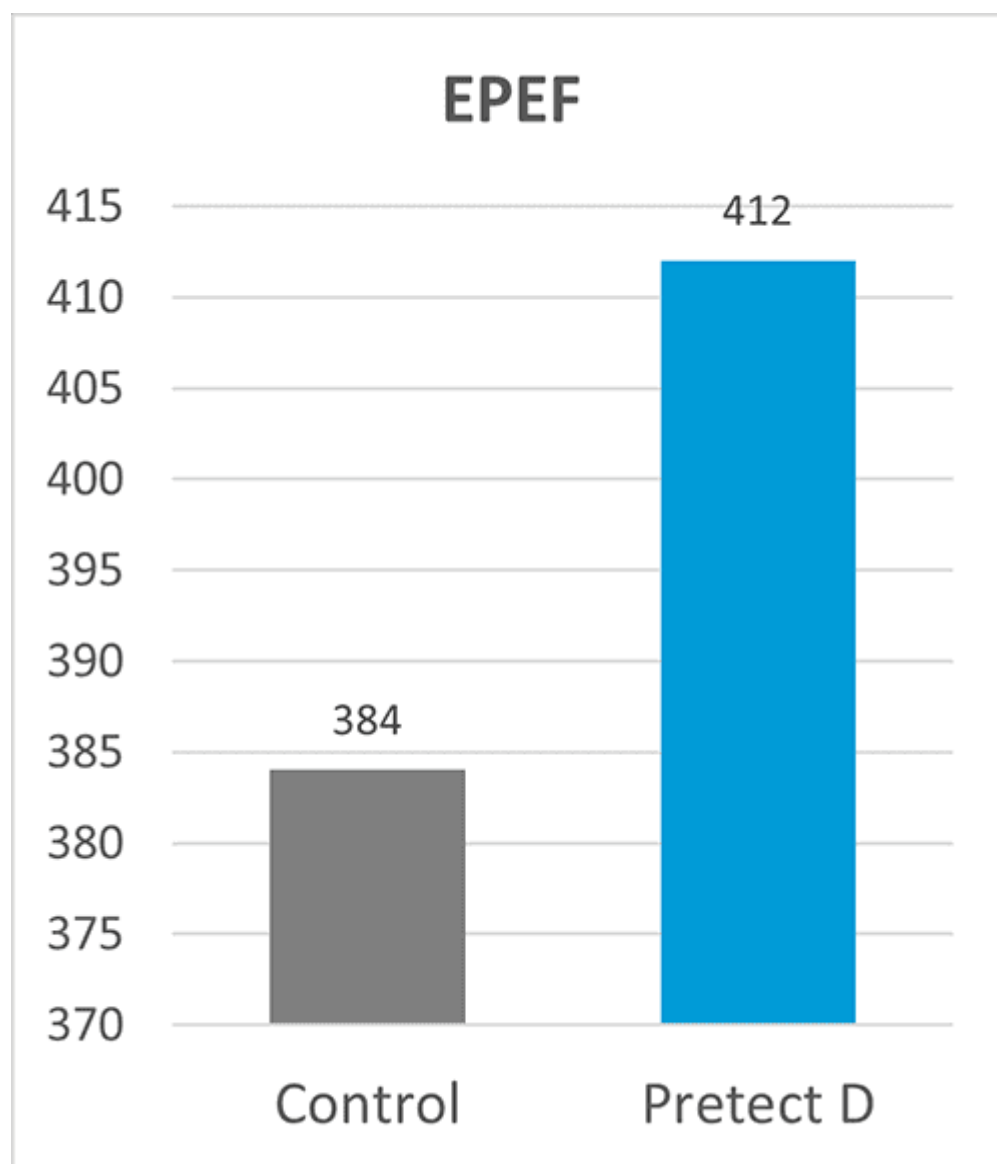


FCR



Mortality (%)





Figures 1-4: Zootechnical performance of broilers with Pretect D included in the shuttle program

Trials show that **Pretect D supports the efficiency of coccidiosis control programs** by impairing the *Eimeria* development cycle when used in combination with vaccines, ionophores, and chemicals as part of the shuttle or rotation program:

- It protects the epithelium from inflammatory and oxidative damage
- It promotes the restoration of the mucosal barrier function

Table 1 exemplifies one way of including a natural solution (Pretect D) in actual coccidiosis control programs.

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6 - Onwards
1	Coccidiostat					Pretect D
2	Coccidiostat			Pretect D		
3	Pretect D					
4	Vaccine			Pretect D		

Table 1: Example of including Pretect D into coccidiosis control programs

Natural solutions suit both farmers and consumers

With phytomolecules partly replacing anticoccidials in rotation or shuttle programs, the use of anticoccidials in poultry production can be decreased. On the one hand, this answers consumers' demand; on the other hand, it leads to a push-back of resistances in the long run. The returning effectiveness of the anticoccidials can reduce subclinical coccidiosis, leading to lower costs spent on this disease and a higher profit for the farmers.

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How to mitigate quality degradation in broiler breasts



By **Dr. Inge Heinzl**, Editor, and **Dr. Ajay Bhojar**, Global Technical Manager Poultry, EW Nutrition

Faster growth of breast muscle in broilers may lead to increased incidences of different types of muscle degeneration. Downgrading the affected breast fillets results in high economic losses for the poultry meat industry.

The article discusses the three important myopathies impairing the breast muscles, their impact on the

meat industry, influencing factors, and how to cope with these challenges.

Muscle degeneration heaps up with faster broiler growth

According to Sirri and co-workers (2016), breast fillets from broilers with 3.9 kg live weight carry a higher risk for myopathic lesions. Studies in different countries revealed that myopathies in broilers are not neglectable:

Country	Myopathy	Number of breasts examined	Conditions	Occurrence	Reference
Italy	WS	28,000 broilers	commercial	12 %	Petracci et al., 2013
Italy	WS	70 flocks; always 500 of 35,000 breasts randomly examined	commercial	43%, with 6.2% considered severe	Lorenzi et al., 2014
Italy	WS	57 flocks	commercial	70.2 % (medium)-82.5 % (heavy-weight)	Russo et al., 2015
Italy	WS	16,000 samples	commercial	9 % moderate 22 % severe	Petracci in Baldi et al., 2020
Brazil	WS	25,520	commercial	10 %	Ferreira et al., 2014
USA	WS	960 (week 6)+ 960 (week 9)	experimental	Score 1: 78.4 % (wk 6) 29.9 % (wk 9) Score 2: 14.0 % (wk 6) 53.9 % (wk 9) Score 3: 0 % (wk 6) 15.1 % (wk 9)	Kuttapan et al., 2017
Brazil	WB		commercial	10-20 %	Carvalho, in Petracci et al., 2019
Italy	WB	16,000 samples	commercial	42 % moderate 18 % severe	Petracci, in Baldi et al., 2020
China	WB	1,135 breast fillets	commercial	61.9%	Xing et al., 2020
USA	WB	960 (week 6)+ 960 (week 9)	experimental	Score 1: 32.5 % (wk 6) 33.2 % (wk 9) Score 2: 7.9 % (wk 6) 36 % (wk 9) Score 3: 1.96 % (wk 6) 15.6 % (wk 9)	Kuttapan et al., 2017
Italy	SM	16,000 samples	commercial	4 % moderate 17 % severe	Petracci in Baldi et al., 2020
Brazil	SM	5,580 samples	commercial	10 %	Montagna et al., 2019



Figure 1: Different myopathies in broilers (R. Baileys)

As the appearance of products is one of the most important arguments for the purchase decision, these myopathies are serious issues; the downgrading of the breast quality results in a lower reward for the producer. Kuttapan et al. (2016) estimated that 90 % of the broilers are affected by wooden breast and white striping (see below), causing about \$200 million to \$1 billion of economic losses to the U.S. poultry industry per year.

Wooden Breast (WB), a result of the proliferation of connective tissues

The muscle affected by the wooden breast is bulging and hard, is covered with clear, viscous fluid, and shows petechiae (see figure 2). The myopathy of the pectoralis major is “pale expansive areas of substantial hardness accompanied by white striation” (Kuttapan, 2016; Huang and Ahn, 2018; Sihvo et al., 2013). It is characterized by microscopically visible polyphasic myodegenerations with fibrosis in the chronic phase. At approximately two weeks of age, it appears as a focal lesion but then develops as a widespread fibrotic injury (Papah et al., 2017). WB can be detected by palpating the breast of the live bird.

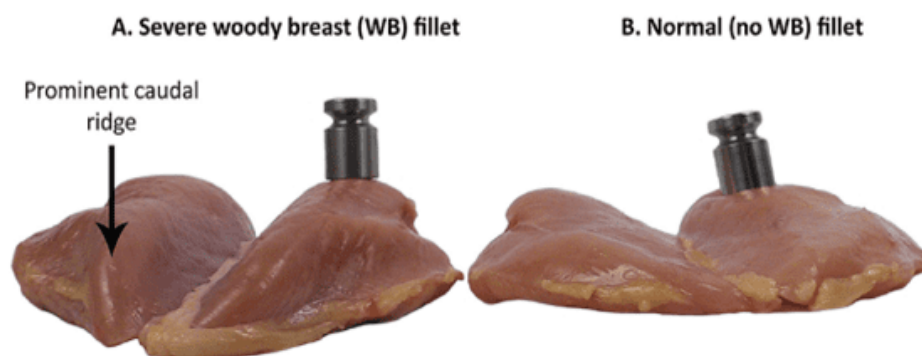


Figure 2: Comparison of a severe wooden breast (on the left) and a healthy breast fillet (on the right)

Source: Kuttapan et al., 2016

According to Kuttapan et al. (2016), the anomaly is caused by circulatory insufficiency and increased oxidative stress resulting in damage and degeneration. Its occurrence rose with increasing growth and slaughter weights of the birds. Wooden breast is more common in male than female broilers as they show an increased expression of genes related to the proliferation of connective tissues (Baldi et al., 2021).

The hardness of the meat, a 1.2 – 1.3 % higher fat content (Soglia et al., 2016, Tasoniero et al., 2016), and the worse appearance lead to a degradation of the fillet quality (Kuttapan et al., 2012). The reduction in the water holding capacity of muscle results in toughness before and after cooking.

White Striping (WS), a result of fiber degeneration

The characteristics of WS are white striations parallel to the muscle fibers. A microscopic examination of these white stripes reveals an accumulation of lipids and a proliferation of connective tissue occurring in breast fillets and thighs (Kuttappan et al., 2013a; Huang and Ahn, 2018). Kuttapan et al. (2016) adapted a scoring system for the evaluation of the severity of WS, which he had established earlier (Kuttapan et al., 2012)(see picture 1). It was concluded that broilers fed a diet with high energy content led to higher and more efficient growth (improved feed conversion, higher live and fillet weights) but also to a higher percentage of fillets showing a severe degree of white striping.



Figure 3: Different degrees of white striping

- 0** = normal (no distinct white lines)
 - 1** = moderate (small white lines, generally < 1 mm thick)
 - 2** = severe (large white lines, 1-2 mm thick, very visible on the fillet surface)
 - 3** = extreme (thick white bands, > 2 mm thickness, covering almost the entire surface of the fillet)
- (scoring and image source: Kuttapan, 2016)

Moreover, the WB and WS can simultaneously occur in the same muscle (Cruz et al., 2016; Kuttappan, Hargis, & Owens, 2016; Livingston, Landon, Barnes, & Brake, 2018).

Spaghetti Meat (SM), a result of decreased collagen linking

The condition of Spaghetti Meat was first mentioned by Bilgili (2015) under “Stringy-spongy”. SM is characterized by an insufficient bonding of the muscles due to an immature intramuscular connective tissue in the pectoralis major. The fiber bundles composing the breast muscle detach, and the muscle gets soft and mushy and resembles spaghetti pasta (Baldi et al., 2021). Probably due to the reduced collagen-linking degree, the texture of SM fillets is smoother after cooking (Baldi et al., 2019). In contrast to wooden breast, SM cannot be noticed in the living animal. Meat severely impacted by SM is downgraded and can only be used in further processed products, whereas slightly affected meat can be sold in fresh retailing (Petracci et al., 2019).

Another possible explanation for this myopathy may be the strong development of the breast muscle. The thickness of its upper section might reduce muscular oxygenation by compressing the pectoral artery (Soglia et al., 2021). The spaghetti structure generally appears mainly in the superficial layer and less in the deep ones.

Oxidative stress – one link in the chain of causes for myopathies

Oxidative stress is a result of impaired blood supply

Oxidative stress is one key factor of myopathies in breast muscle. As the faster growth is connected with an increase in muscle fiber diameter, the higher pressure of the surrounding fascia on the muscle tissue compresses the blood vessels, leading to a decreased blood flow, resulting in insufficient oxygen supply (hypoxia) and limited removal of metabolic by-products (Lilburn et al., 2019) from the muscle tissue. Hypoxia as – well as hyperoxia – plus the deficient removal of metabolic waste, promote the generation of free radicals (Kähler et al., 2016; Strapazzon et al., 2016; Petrazzi et al., 2019). If the endogenous antioxidant system cannot efficiently eliminate these ROS by using endogenous and exogenous antioxidants, the ultimate effect is increased oxidative stress.

Soglia and co-workers (2016) reported higher TBARS (Thiobarbituric acid reactive substances) and protein carbonyl levels, signs of oxidative stress, in severe wooden breast muscle tissue. The oxidative stress hypothesis was also supported by gene transcription analysis conducted by Mutryn et al. (2015) and Zambonelli et al. (2017).

Oxidative stress causes damage

ROS (reactive oxygen species) or free radicals are highly reactive. They can cause damage to the DNA, RNA, proteins, and lipids in the muscle cells (Surai et al., 2015), leading to inflammation and metabolic disturbances, and, in the end, the degeneration of muscle fibers (Kuttapan et al., 2021). If the regenerative capacity of the muscle cells does not countervail against the damages caused by oxidative stress, fibrous tissue and fat accumulate and lead to myopathies such as wooden breast (Petracci et al., 2019)

Oxidative stress can be managed

To support the animals in coping with oxidative stress, combining two approaches, an external and an internal, makes sense. This entails protecting feed at the same time as protecting the animal.

Chemical antioxidants preserve feed quality and prevent oxidation

Chemical antioxidants such as ethoxyquin, BHA, and BHT efficiently prevent feed oxidation. These antioxidants prevent the oxidation of unsaturated fats/oils and maintain their energy value. They are scavengers for free radicals, protect trace minerals like Zn, Cu, Mg, Se, and Vit E from oxidation and spare them to be used in the body for different metabolic processes as well as for the endogenous antioxidant system.

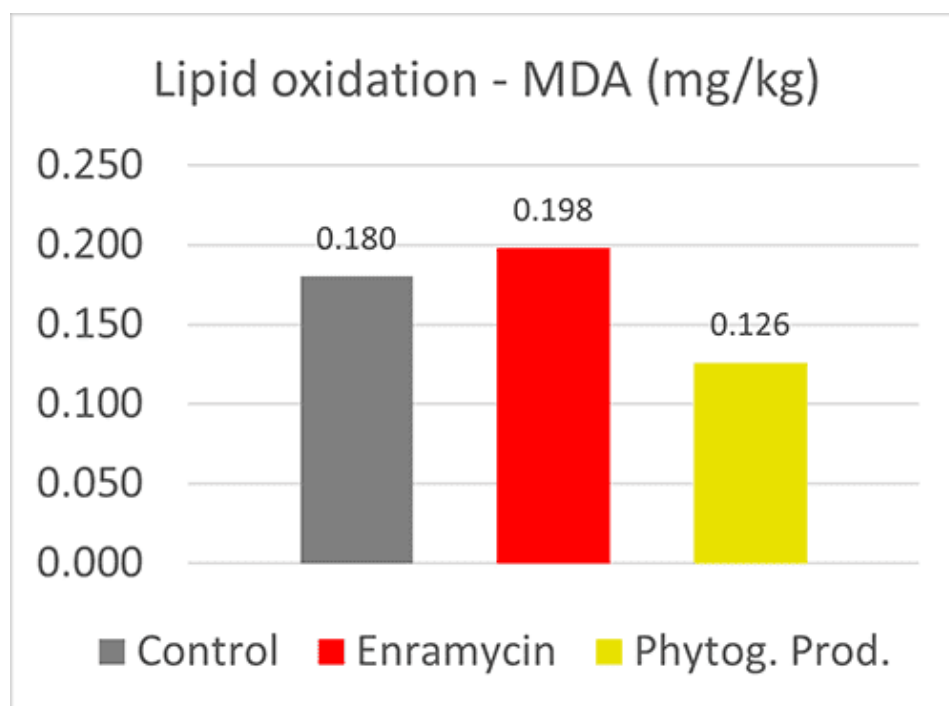
However, keep in mind that chemical antioxidants are strictly regulated, depending on type, concentration, and region. Ethoxyquin has a challenging status in the EU, for instance, due to a [ruling](#) that excludes it for the use of long-living or reproductive animals and that sets safety levels at a maximum total concentration of 50 mg ethoxyquin/kg complete feed for all animal species, except dairy ruminants.

Phytomolecules act as natural antioxidants and reduce lipid oxidation in breast muscles

Inside the body, phytomolecules help to mitigate oxidative stress by the direct scavenging of ROS and the activation of antioxidant enzymes. Phytochemical compounds like Carvacrol and thymol possess phenolic OH-groups that act as hydrogen donors (Yanishlieva et al., 1999). These hydrogens can “neutralize” the peroxy radicals produced during the first step of lipid oxidation and, therefore, retard the hydroxyl peroxide formation. The increase in serum antioxidant enzyme activities and a resulting lower level of malondialdehyde (MDA) can be caused by cinnamaldehyde (Lin et al., 2003). MDA is a highly reactive dialdehyde generated as a metabolite in the degradation process of polyunsaturated fatty acids.

Antioxidant capacity of phytomolecules demonstrated in broilers

A trial with 480 Cobb male chicks (3 treatments, 8 replicates) was conducted at the University of Viçosa (Brazil). The breast muscles of the birds fed a blend of phytomolecules showed lower MDA levels and thus reduced lipid oxidation compared to the negative control, but also to the birds fed an antibiotic.



The impact of breast muscle degradation in broilers can be mitigated

The downgrading of broiler meat due to increased incidence of breast muscle myopathies is a common issue, resulting in the significant economic losses to the broiler meat producers. Oxidative stress caused due to faster growth rate and various other stressors, including the oxidation of feed and feed ingredients, can contribute to increased incidence of woody breast and white striping. Different nutritional and management strategies are employed to reduce WB and WS in broiler production. The inclusion of synthetic antioxidants to control the oxidation in feed as well as phytomolecules to support the

endogenous antioxidant system can be a part of promising tools to mitigate the impact of breast myopathies and reduce economic losses in broiler production.

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