

Mitigating Eimeria resistance in broiler production with phytogetic solutions



By Dr. Ajay Bhojar, Global Technical Manager, EW Nutrition

In modern, intensive poultry production, the imminent threat of resistant *Eimeria* looms large, posing a significant challenge to the sustainability of broiler operations. *Eimeria* spp., capable of developing resistance to our traditional interventions, has emerged as a pressing global issue for poultry operators. The resistance of *Eimeria* to conventional drugs, coupled with concerns over drug residue, has necessitated a shift towards natural, safe, and effective alternatives.

Several phytogetic compounds, including saponins, tannins, essential oils, flavonoids, alkaloids, and lectins, have been the subject of rigorous study for their anticoccidial properties. Among these, saponins and tannins in specific plants have emerged as powerful tools in the fight against these resilient protozoa. In the following, we delve into innovative strategies that leverage the potential of these compounds, particularly saponins and tannins, to prevent losses by mitigating the risk of resistant *Eimeria* in poultry production.

Understanding resistant *Eimeria* in broiler

production

The World Health Organization Scientific Group ([World Health Organization, 1965](#)) developed the definition of resistance in broad terms as 'the ability of a parasite strain to survive and/or to multiply despite the administration and absorption of a drug given in doses equal to or higher than those usually recommended but within the limits of tolerance of the subject'.

The high reproduction rate of *Eimeria spp.* allows them to evolve quickly and develop resistance to drugs used for their control. Moreover, the resistant strains of *Eimeria* can persist in the environment due to their ability to form resistant oocysts, leading to the re-infection of animals and further spread of resistant strains.

Resistant *Eimeria* strains present many challenges in modern poultry farming, significantly impacting overall productivity and economic sustainability. However, one of the primary challenges is the reduced efficacy of traditional anti-coccidial drugs.

Eimeria resistance occurs in different types

There are different possibilities as to why *Eimeria* are resistant to specific drugs.

Acquired resistance results from heritable decreases in the sensitivity of specific strains and species of *Eimeria* to drugs over time. There are two types of acquired resistance: partial and complete. These types depend upon the extent of sensitivity lost. There is a direct relationship between the concentration of the drug and the degree of resistance. A strain controlled by one drug dose may show resistance when a lower concentration of the same drug is administered.

Cross-resistance is the sharing of resistance among different compounds with similar modes of action ([Abbas et al., 2011](#)). This, however, may not always occur ([Chapman, 1997](#)).

Multiple resistance is resistance to more than one drug, even though they have different modes of action ([Chapman, 1993](#)).

Natural substances can bring back the efficacy of anticoccidial measures

It was found that if a drug to which the parasite has developed resistance is withdrawn from use for some time or combined with another effective drug, the sensitivity to that drug may return (Chapman, 1997).

Botanicals and natural identical compounds are well renowned for their antimicrobial and antiparasitic activity, so they can represent a valuable tool against *Eimeria* ([Cobaxin-Cardenas, 2018](#)). The mechanisms of action of these molecules include degradation of the cell wall, cytoplasm damage, ion loss with reduction of proton motive force, and induction of oxidative stress, which leads to inhibition of invasion and impairment of *Eimeria spp.* development ([Abbas et al., 2012](#); [Nazzaro et al., 2013](#)). Natural anticoccidial products may provide a novel approach to controlling coccidiosis while meeting the urgent need for control due to the increasing emergence of drug-resistant parasite strains in commercial poultry production ([Allen and Fetterer, 2002](#)).

Saponins and Tannins: Nature's Defense against

Eimeria Challenge

Phytogenic solutions, specifically those based on saponins and tannins, have recently surfaced as promising alternatives to mitigate the Eimeria challenge in poultry production. By harnessing the power of these natural compounds, poultry producers can boost the resilience of their flocks against the Eimeria challenge, promoting both the birds' welfare and the industry's sustainability.

Saponins are glycosides found in many plants with distinctive soapy characteristics due to their ability to foam in water. In the context of Eimeria, saponins can disrupt the integrity of the parasites' cell membranes. When consumed, saponins can interfere with the protective outer layer of Eimeria, weakening the parasite and rendering it vulnerable to the host's immune responses. This disruption impedes the ability of Eimeria to attach to the intestinal lining and reproduce, effectively curtailing the infection.

Tannins are polyphenolic compounds with astringent properties, occurring in various plant parts, such as leaves, bark, and fruits. Choosing the proper tannin at the right level and time is crucial to realize the benefits of tannin-based feed additives.

In the context of Eimeria, tannins exhibit several mechanisms of action. Firstly, they bind to proteins within the parasites, disrupting their enzymatic activities and metabolic processes. This interference weakens Eimeria, hindering its ability to cause extensive damage to the intestinal lining. Secondly, tannins are anti-inflammatory, reducing the inflammation caused by Eimeria infections. Additionally, tannins act as antioxidants, protecting the intestinal cells from oxidative stress induced by the parasite.

When incorporated into broilers' diets, saponins and tannins create an unfavorable environment for Eimeria, inhibiting their growth and propagation within the host. Moreover, these compounds fortify the broiler's natural defenses, enhancing its ability to resist Eimeria infections. By leveraging the innate properties of saponins and tannins, the impact of resistant Eimeria strains can effectively be managed and mitigated, fostering healthier flocks and sustainable poultry production.

What is Pretect D?

Prectect D is a unique proprietary blend of phytochemicals, including saponins and tannins, that supports the control of coccidiosis challenges in poultry production. It can be used alone or in combination with coccidiosis vaccines, ionophores, and chemicals as part of a shuttle or rotation program.

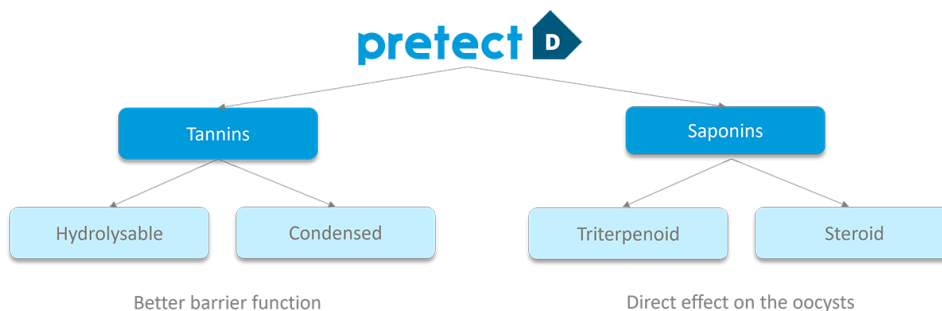


Fig.1. Key active ingredients of Pretect D

Modes of action of Pretect D

Prectect D exhibits multiple modes of action to optimize gut health during challenging times. Due to its anti-protozoal, anti-inflammatory, immunomodulatory, and antioxidant properties, it

- a. effectively decreases oocyst excretion and disease spread
- b. promotes restoring the mucosal barrier function and improves intestinal morphology
- c. protects the intestinal epithelium from inflammatory and oxidative damage.

The beneficial effects of Pretect D

The beneficial effects of Pretect D's inclusion in the coccidiosis control program include improving overall gut health and broiler production performance.

In a challenge study with Cobb 500 broiler chicks under a mixed *Eimeria* inoculum challenge, it was evident that the group receiving Pretect D (@500g/ton) in the feed throughout the 35-day rearing period had less coccidia-caused lesions (D27) than the broilers challenged and fed control diets.

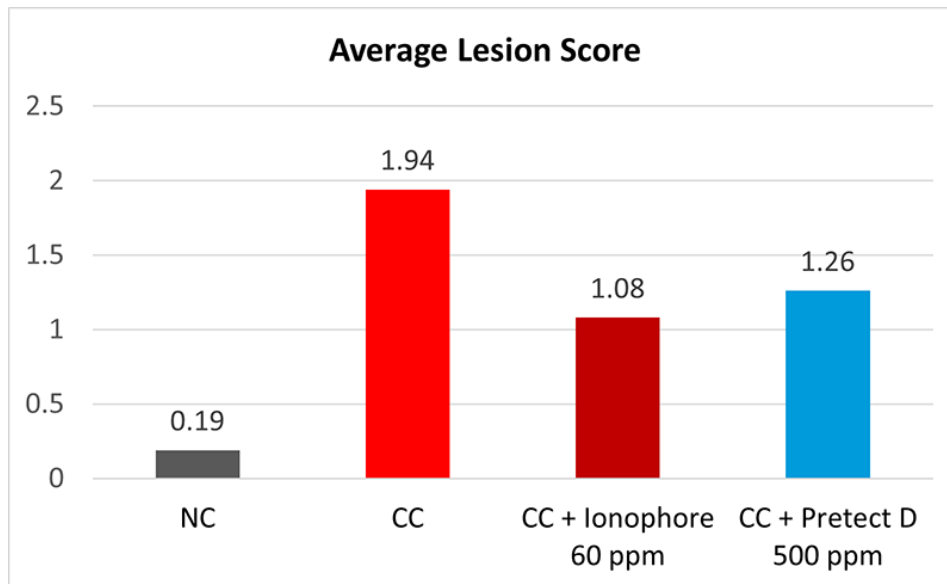
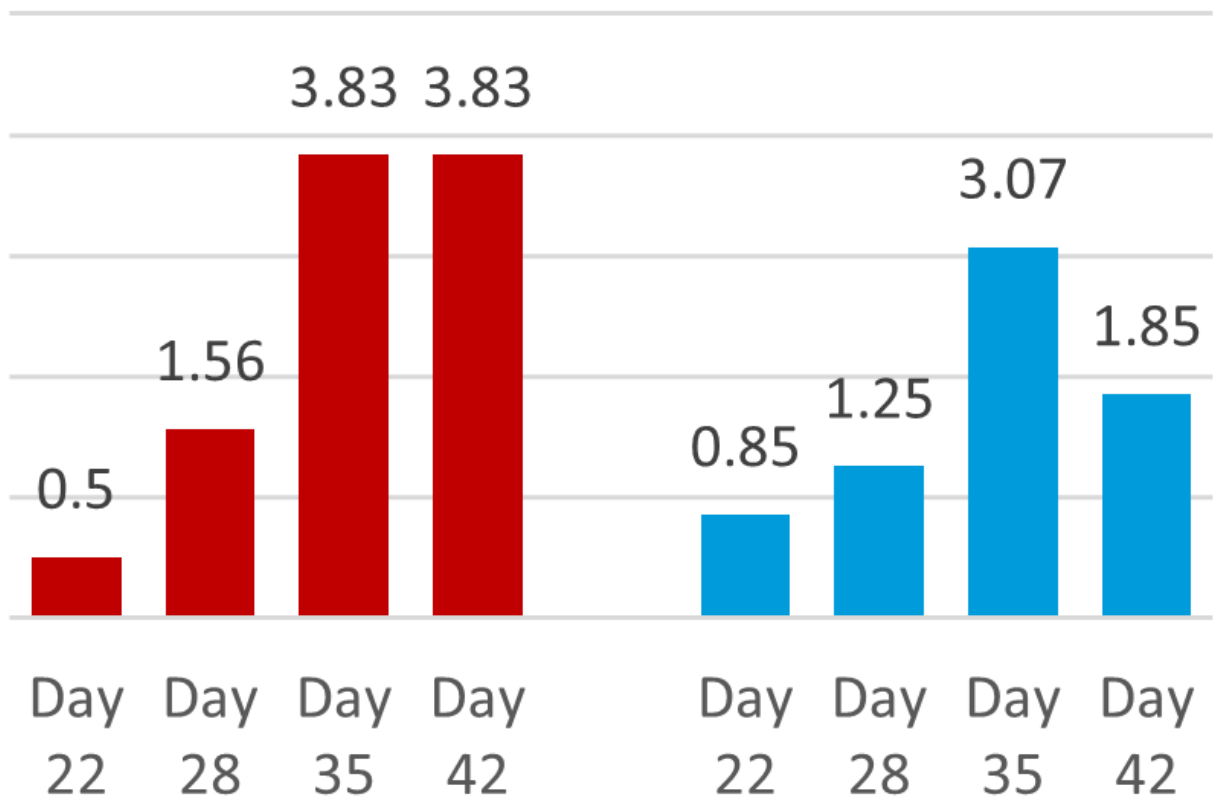


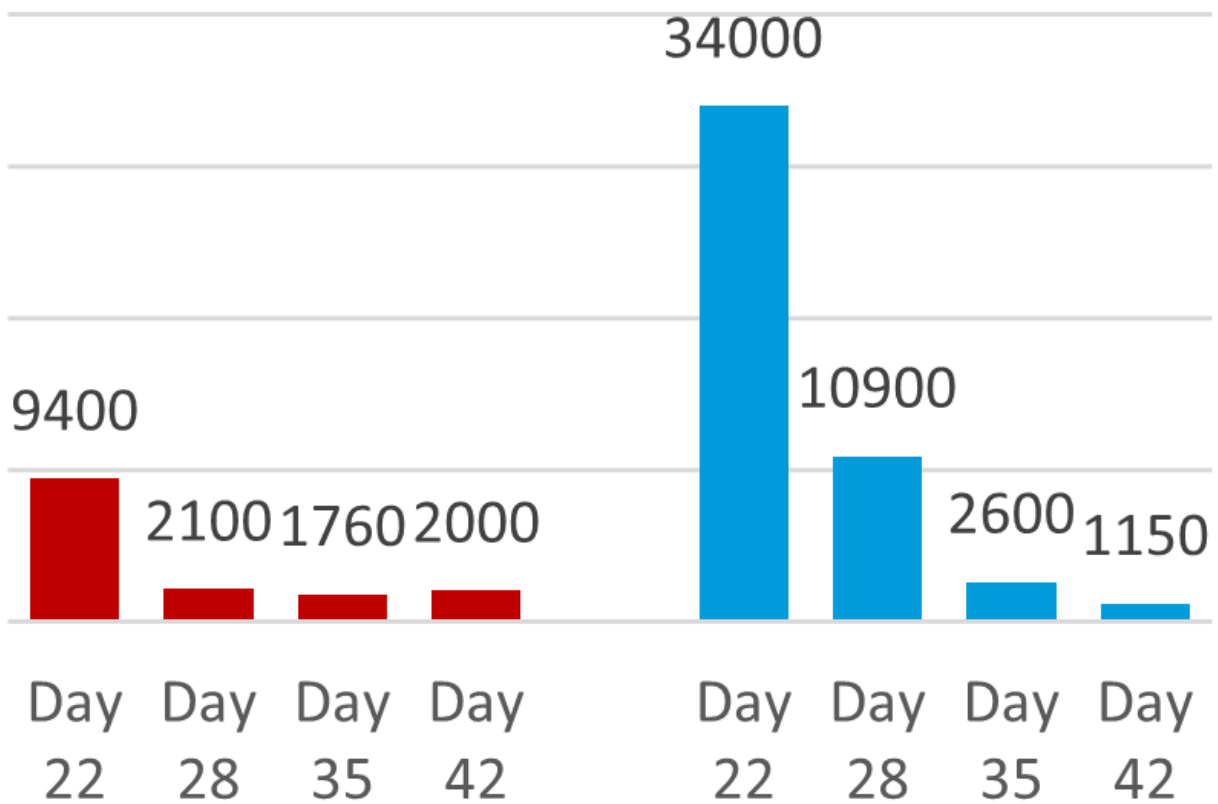
Fig. 2: Pretect D reduced coccidia-caused lesions in broilers

In another field study, a traditional anticoccidial program (Starter and Grower I feeds: Narasin + Nicarbazin, Grower II feed: Salinomycin, Finisher/ withdrawal feeds: No anticoccidial) was compared with a program combining anticoccidials with Pretect D (Starter and Grower I feeds: Narasin + Nicarbazin, Grower II and Finisher feeds: Pretect D). The addition of Pretect D significantly reduced OPG count and lowered the coccidiosis lesion score compared to the control (Fig. 3).

Lesion score



OPG

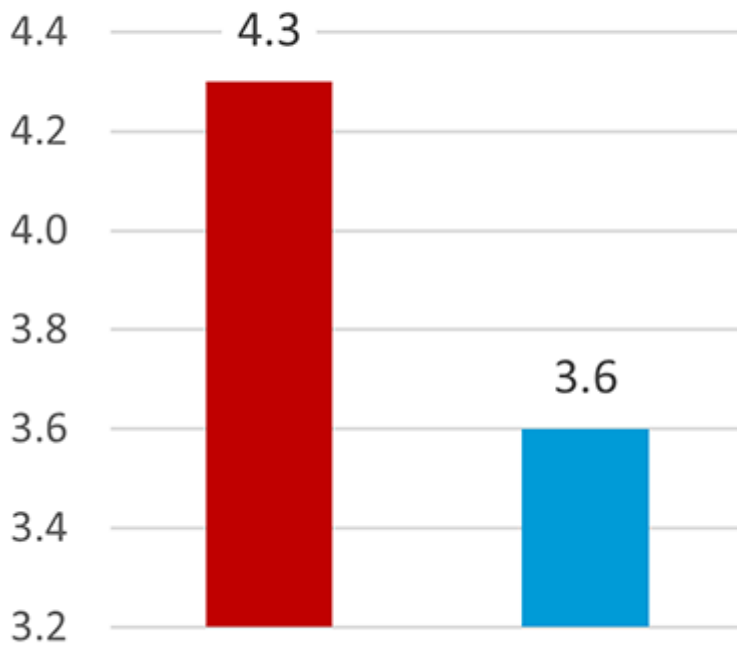


 Traditional anticoccidial program  Pretect D

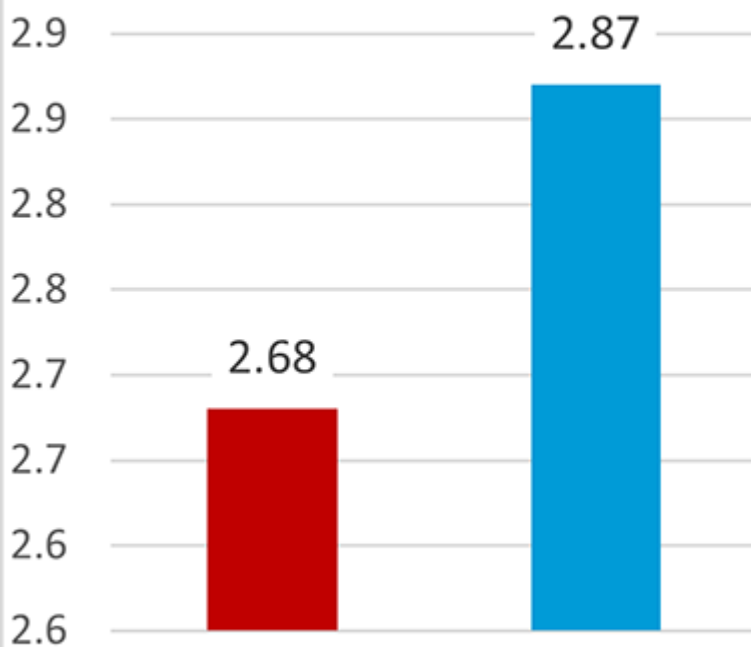
Fig.3. Pretect D reduced broilers' coccidiosis lesion score and OPG count

Consequently, broilers receiving Pretect D showed better overall production performance.

Mortality (%)



Bodyweight (kg)



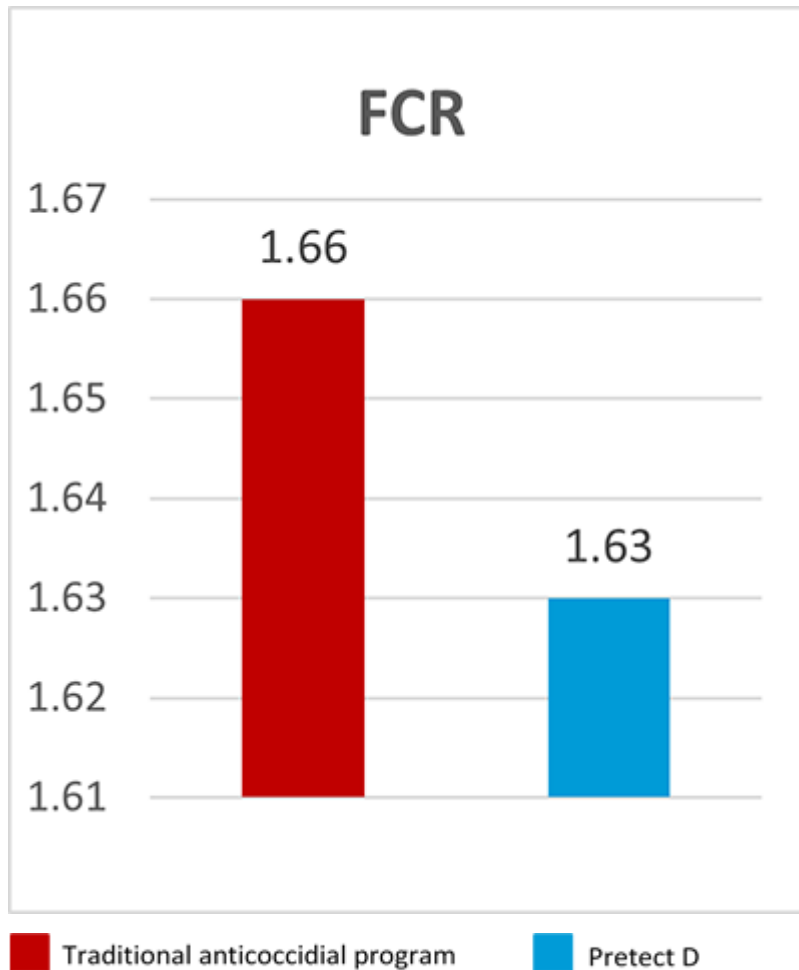


Fig. 4. Overall improved production performance by Pretect D

Pretect D: Application Strategies

The introduction of an effective phylogenetic combination in the coccidiosis control program can help mitigate the drug resistance issue. Such a natural anticoccidial solution can be used as a standalone, preferably in less challenging months, as well as in combination with chemicals (shuttle/ rotation) or a coccidiosis vaccine (bio-shuttle), reducing the need for frequent drug use.

Shuttle programs are commonly employed for managing coccidiosis, and they yield a satisfactory level of success. Within these programs, multiple drugs from distinct classes of anticoccidials are administered throughout a single flock. For instance, one class of drug is utilized in the starter feed, another in the grower stage, reverting to the initial class for the finisher diet and concluding with a withdrawal period.

In rotation programs, anticoccidial drugs are alternated between batches rather than within a single batch.

Conclusions

Coccidiosis is considered one of the most economically significant diseases of poultry and the development of anticoccidial resistance has threatened the profitability of the broiler industry. Therefore, regularly monitoring *Eimeria* species to develop resistance against different anticoccidial groups is crucial to managing resistance and choosing an anticoccidial. It would be rewarding to use an effective phylogenetic solution in the coccidiosis control program as a strategic and tactical measure and to focus on such integrated programs for drug resistance management in the future.

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Respiratory disease - one of the biggest problems in horses



By Judith Schmidt, Product Manager On-Farm Solutions

The respiratory tract in horses is prone to various problems, ranging from allergic reactions and inflammation to severe infections. Respiratory diseases are a constant topic of suffering and irritation in horse breeding and keeping. According to a study published in 2005, respiratory diseases account for about 40 % of all equine internal diseases recorded worldwide (Thein 2005). Through early diagnosis, appropriate treatment, and preventive measures, horse owners can help maintain the respiratory health of their horses and promote their well-being and performance.

The horse's lung - a high-performance organ

The respiratory tract of our horses is a high-performance system with a large surface, allowing the exchange between the inside of the body and the environment. The lungs enable the gas exchange, i.e., the transfer of oxygen from the air into the horse's bloodstream and the discharge of CO₂. A functioning gas exchange is crucial for the horse to supply its muscles with sufficient oxygen and perform.

Even when resting, a 600-kg horse breathes about 50 to 80 liters of air per minute into its lungs. With increasing load, this value can rise to 2.000 liters per minute at maximum load. If a horse is healthy, it breathes calmly and slowly and takes eight to sixteen deep breaths per minute.

A special mucous membrane covering the entire respiratory tract protects the lungs from harmful influences. When irritated by pathogens or foreign bodies, this mucous membrane generates higher amounts of mucous and transports it toward the mouth cavity with the help of the finest cilia. In this way, most harmful particles are usually trapped quickly, reliably, and, above all, effectively and, if necessary, coughed up before they can even reach the alveoli and cause damage there.

The most common respiratory diseases in horses

Chronic obstructive bronchitis

Chronic obstructive bronchitis is better known as COB or equine asthma. COB is more common in horses regularly kept in dusty or poorly ventilated environments, such as cramped stables or pastures with high mold levels. Inhalation of dust particles and allergens can cause respiratory tract inflammation, leading to coughing, increased mucus expectoration, and breathing difficulties. The clinical picture of COB can vary greatly. From occasional poor performance in show horses to chronic coughing with purulent nasal discharge or significant weight loss.

Tracheitis

Another common respiratory disease in horses is tracheitis, often caused by bacterial or viral infections. Young and older horses and those with a weakened immune system are particularly susceptible to tracheitis. Besides infections, factors such as dust, smoke, or chemicals can also irritate the mucous membrane of the trachea and trigger inflammation.

Hay fever

Hay fever, also known as allergic respiratory disease or rhinitis, is a common condition affecting horses. Known to humans, it is an allergic reaction to certain pollen, molds, or other environmental allergens that are present in the air. Common signs include sneezing, a runny nose, and itchy eyes. However, some horses may also suffer from coughing or respiratory symptoms. Hay fever in horses can occur seasonally, depending on the pollen emerging, and the symptoms may be more severe during spring, summer, or autumn.

Asthma

Asthma in horses, also known as equine asthma or heaves, is a chronic respiratory disease similar to asthma in humans in many ways. The main cause of this disease is hypersensitivity of the respiratory tract to dust, allergens, or mold spores in the horses' environment.

How to differentiate between respiratory distress and harmless rattling?



Horse owners know it – the four-legged friends have an impressive range of breathing sounds. But which are harmless, such as the excited trumpeting through the nostrils during a fright, and which could be respiratory disease symptoms?

Diagnosing respiratory problems in horses can be challenging because symptoms are often non-specific signs and similar to several diseases.

Snorting: When horses snort, it is a sign of relaxation. There is usually no cause for concern—quite the opposite.

Snorting at a gallop: Many horses snort rhythmically at a gallop, which is also considered harmless. Snorting is particularly common in thoroughbreds.

Coughing during, e.g., trotting: Occurs so frequently that it is often perceived as usual. But it is not. Coughing is always an alarm signal and can indicate an allergy, asthma, or a viral or bacterial infection.

Whistling when inhaling: In this case, to be on the safe side, a veterinarian should be consulted.

What are the consequences of respiratory disease?

Respiratory disease in horses can have significant economic consequences. If a horse suffers from chronic obstructive bronchitis or another respiratory illness, this can lead to various problems:

- **Veterinary costs increase:** Diagnosing and treating respiratory diseases often require veterinary visits, medication, and possibly further examinations such as x-rays or endoscopy.
- **Performance decreases:** A horse with respiratory problems may have severely limited performance. It may have difficulty breathing, negatively affecting its athletic performance, equestrian work, or other activities.
- **Downtime:** During the treatment or recovery, horses may have to take a break or be taken out of training, resulting in loss of income, especially if the horse was intended for competition or show.
- **Decrease in value:** A horse with chronic respiratory problems may lose its value as a sport or breeding horse. The demand for that horse and, therefore, the selling price might decrease.

Early diagnosis and treatment are crucial for containing the economic impact. However, the best strategy is to minimize the risk of respiratory disease by appropriate preventive measures.

Prevention

Preventing cough in horses is considerably important to reduce the incidence and severity of respiratory disease. Several measures can be taken to achieve this goal:

1. A clean horse stable is crucial: Dust is a common trigger of respiratory symptoms in horses. Removing dust, dirt, and mold spores regularly from the stable and horse boxes can help improve air quality and reduce respiratory stress.
2. Allow horses to breathe fresh air with efficient pasture management: When possible, horses should have access to fresh pastures. The natural outdoor environment helps horses breathe cleaner air and inhale fewer harmful particles.
3. Hay feeding should not increase exposure to allergens: The exposure to allergens can be reduced by choosing high-quality, low-dust hay. Moist soaking of the hay before feeding can also help reduce dust levels.
4. Ventilation ensures air exchange: Appropriate ventilation in the stable is essential to avoid stagnant air and dust accumulation. The use of fans or natural ventilation systems can improve air circulation.
5. Feed management: High-quality feed free of molds and allergens can reduce the risk of respiratory problems. It is vital to adjust feed rations to the individual needs of each horse.
6. Supplements support hygiene measures: Supplements can play a positive role in preventing respiratory problems in horses if used selectively and with expert advice.
 - Immune system support: Supplements such as vitamins, minerals, and antioxidants can strengthen the immune system. A healthy immune system helps the horse to better defend itself against infections and inflammation of the respiratory tract.
 - Certain supplements contain ingredients with anti-inflammatory properties, such as omega-3 fatty acids or herbal extracts. They can help alleviate inflammation in the respiratory tract and thus reduce the risk of respiratory problems.
 - Supporting respiratory health: Some supplements on the market have been specially designed to support respiratory function. They help regulate mucus production, improve respiratory protection, and facilitate the expectoration of mucus.
 - Strengthening lung capacity: Certain ingredients in supplements can support the horse's lung capacity and promote better oxygen uptake, which is essential for performance and respiratory health.

Conclusion

Respiratory health is essential for horses. So, you should consult the vet in case of noticeable breathing sounds, coughing, fever, or a drop in performance. Respiratory diseases tend to become chronic and long-term problems if they are not treated appropriately. Fresh air and species-appropriate husbandry, feeding dust- and mold-free feed are the first steps to support the normal function of your horse's respiratory tract. A holistic approach to equine health, including proper stable and feed hygiene, sufficient exercise, and good air quality in the stable is crucial. Appropriate feed supplements can be an excellent tool to round this approach off.

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The future of coccidiosis control



By **Madalina Diaconu**, Product Manager Pretect D, EW Nutrition and

With costs of over 14 billion USD per year (Blake, 2020), coccidiosis is one of the most devastating enteric challenges in the poultry industry. With regard to costs, subclinical forms of coccidiosis account for the majority of production losses, as damage to intestinal cells results in lower body weight, higher feed conversion rates, lack of flock uniformity, and failures in skin pigmentation. This challenge can only be tackled, if we understand the basics of coccidiosis control in poultry and what options producers have to manage coccidiosis risks.

Current strategies show weak points

Good farm management, litter management, and coccidiosis control programs such as shuttle and rotation programs form the basis for preventing clinical coccidiosis. More successful strategies include disease monitoring, strategic use of coccidiostats, and increasingly coccidiosis vaccines. However, the intrinsic properties of coccidia make these parasites often frustrating to control. Acquired resistance to available coccidiostats is the most difficult and challenging factor to overcome.

Optimally, coccidiosis control programs are developed based on the farm history and the severity of infection. The coccidiostats traditionally used were chemicals and ionophores, with ionophores being polyether antibiotics. To prevent the development of resistance, the coccidiostats were used in shuttle or rotation programs, at which in the rotation program, the anticoccidial changes from flock to flock, and in the shuttle program within one production cycle (Chapman, 1997).

The control strategies, however, are not 100% effective. The reason for that is a lack of diversity in available drug molecules and the overuse of some molecules within programs. An additional lack of sufficient coccidiosis monitoring and rigorous financial optimization often leads to cost-saving but only marginally effective solutions. At first glance, they seem effective, but in reality, they promote resistance, the development of subclinical coccidiosis, expressed in a worsened feed conversion rate, and possibly also clinical coccidiosis.

Market requests and regulations drive coccidiosis control strategies

Changing coccidiosis control strategies has two main drivers: the global interest in mitigating antimicrobial resistance and the consumer's demand for antibiotic-free meat production.

Authorities have left ionophores untouched

Already in the late 1990s, due to the fear of growing antimicrobial resistance, the EU withdrew the authorization for Avoparcin, Bacitracin zinc, Spiramycin, Virginiamycin, and Tylosin phosphate, typical growth promoters, to "help decrease resistance to antibiotics used in medical therapy". However, ionophores, being also antibiotics, were left untouched: The regulation (EC) No 1831/2003 [13] of the European Parliament and the Council of 22 September 2003 clearly distinguished between coccidiostats and antibiotic growth promoters. Unlike the antibiotic growth promoters, whose primary action site is the gut microflora, coccidiostats only have a secondary and residual activity against the gut microflora. Furthermore, the Commission declared in 2022 that the use of coccidiostats would not presently be ruled out "even if of antibiotic origin" (MEMO/02/66, 2022) as "hygienic precautions and adaptive husbandry measures are not sufficient to keep poultry free of coccidiosis" and that "modern poultry husbandry is currently only practicable if coccidiosis can be prevented by inhibiting or killing parasites during their development". In other words, the Commission acknowledged that ionophores were only still authorized because it believed there were no other means of controlling coccidiosis in profitable poultry production.

Consumer trends drove research on natural solutions

Due to consumers' demand for antibiotic-reduced or, even better, antibiotic-free meat production, intensified industrial research to fight coccidiosis with natural solutions has shown success. Knowledge, research, and technological developments are now at the stage of offering solutions that can be an effective part of the coccidia control program and open up opportunities to make poultry production even more sustainable by reducing drug dependency.

Producers from other countries have already reacted. Different from the handling of ionophores regime in the EU, where they are allowed as feed additives, in the United States, coccidiostats belonging to the polyether-ionophore class are not permitted in NAE (No Antibiotics Ever) and RWE (Raised Without Antibiotics) programs. Instead of using ionophores, coccidiosis is controlled with a veterinary-led combination of live vaccines, synthetic compounds, phytomolecules, and farm management. This approach can be successful, as demonstrated by the fact that over 50% of broiler meat production in the US is NAE. Another example is Australia, where the two leading retail store chains also exclude chemical coccidiostats from broiler production. In certain European countries, e.g., Norway, the focus is increasingly on banning ionophores.

The transition to natural solutions needs knowledge and finesse

In the beginning, the transition from conventional to NAE production can be difficult. There is the possibility to leave out the ionophores and manage the control program only with chemicals of different modes of action. More effective, however, is a combination of vaccination and chemicals (bio-shuttle program) or the combination of phytomolecules with vaccination and/or chemicals (Gaydos, 2022).

Coccidiosis vaccination essentials

When it is decided that natural solutions shall be used to control coccidiosis, some things about vaccination must be known:

1. There are different strains of vaccines, natural ones selected from the field and attenuated strains. The formers show medium pathogenicity and enable a controlled infection of the flock. The latter, being early mature lower pathogenicity strains, usually cause only low or no post-vaccinal reactions.
2. A coccidiosis program that includes vaccination should cover the period from the hatchery till the end of the production cycle. Perfect application of the vaccines and effective recirculation of vaccine strains amongst the broilers are only two examples of preconditions that must be fulfilled for striking success and, therefore, early and homogenous immunity of the flock.
3. Perfect handling of the vaccines is of vital importance. For that purpose, the personnel conducting the vaccinations in the hatchery or on the farms must be trained. In some situations, consistent high-quality application at the farm has shown to be challenging. As a result, interest in vaccine application at the hatchery is growing.

Phytochemicals are a perfect tool to complement coccidiosis control programs

As the availability of vaccines is limited and the application costs are relatively high, the industry has been researching supportive measures or products and discovered phytochemicals as the best choice. Effective phytochemical substances have antimicrobial and antiparasitic properties and enhance protective immunity in poultry infected by coccidiosis. They can be used in rotation with vaccination, to curtail vaccination reactions of (non-attenuated) wild strain vaccines, or in combination with chemical coccidiostats in a shuttle program.

In a recent review paper (El-Shall et al., 2022), natural herbal products and their extracts have been described to effectively reduce oocyst output by inhibiting *Eimeria* species' invasion, replication, and development in chicken gut tissues. Phenolic compounds in herbal extracts cause coccidia cell death and lower oocyst counts. Additionally, herbal additives offer benefits such as reducing intestinal lipid peroxidation, facilitating epithelial repair, and decreasing *Eimeria*-induced intestinal permeability.

Various phytochemical remedies are shown in this simplified adaptation of a table from El-Shall et al. (2022), indicating the effects exerted on poultry in connection to coccidia infection.

Bioactive compound	Effect
Saponins	<p><i>Inhibition of coccidia:</i> By binding to membrane cholesterol, the saponins disturb the lipids in the parasite cell membrane. The impact on the enzymatic activity and metabolism leads to cell death, which then induces a toxic effect in mature enterocytes in the intestinal mucosa. As a result, sporozoite-infected cells are released before the protozoa reach the merozoite phase.</p> <p><i>Support for the chicken:</i> Saponins enhance non-specific immunity and increase productive performance (higher daily gain and improved FCR, lower mortality rate). They decrease fecal oocyst shedding and reduce ammonia production.</p>
Tannins	<p><i>Inhibition of coccidia:</i> Tannins penetrate the coccidia oocyst wall and inactivate the endogenous enzymes responsible for sporulation.</p> <p><i>Support for the chicken:</i> Additionally, they enhance anticoccidial antibodies' activity by increasing cellular and humoral immunity.</p>

Flavonoids and terpenoids	<p><i>Inhibition of coccidia:</i> They inhibit the invasion and replication of different species of coccidia.<i>Support for the chicken:</i> They bind to the mannose receptor on macrophages and stimulate them to produce inflammatory cytokines such as IL-1 through IL-6 and TNF. Higher weight gain and lower fecal oocyst output are an indication of suppression of coccidiosis.</p>
Artemisinin	<p><i>Inhibition of coccidia:</i> Its impact on calcium homeostasis compromises the oocyst wall formation and leads to a defective cell wall and, in the end, to the death of the oocyst. Enhancing the production of ROS directly inhibits sporulation and also wall formation and, therefore, affects the Eimeria life cycle.<i>Support for the chicken:</i> Reduction of oocyst shedding</p>
Leaf powder of Artemisia annua	<p><i>Support for the chicken:</i> Protection from pathological symptoms and mortality associated with Eimeria tenella infection. Reduced lesion score and fecal oocyst output. The leaf powder was more efficient than the essential oil, which could be due to a lack of Artemisinin in the oil, and to the greater antioxidant ability of A. annua leaves than the oil.</p>
Phenols	<p><i>Inhibition of coccidia:</i> Phenols change the cytoplasmic membrane's permeability for cations (H⁺ and K⁺), impairing essential processes in the cell. The resulting leakage of cellular constituents leads to water unbalance, collapse of the membrane potential, inhibition of ATP synthesis, and, finally, cell death. Due to their toxic effect on the upper layer of mature enterocytes of the intestinal mucosa, they accelerate the natural renewal process, and, therefore, sporozoite-infected cells are shed before the coccidia reaches the merozoite phase.</p>

Table 1: Bioactive compounds and their anticoccidial effect exerted in poultry

Consumers vote for natural - phytochemicals are the solution

Due to still rising antimicrobial resistance, consumers push for meat production without antimicrobial usage. Phytomolecules, as a natural solution, create opportunities to make poultry production more sustainable by reducing dependency on harmful drugs. With their advent, there is hope that antibiotic resistance can be held in check without affecting the profitability of poultry farming.

Coccidiosis management without increasing antimicrobial resistance - it's up to us



By **Tingting Fan**, Regional Technical Manager Poultry, EW Nutrition

Chicken coccidiosis is a common and important disease in poultry production, with an incidence of infection as high as 50-70%. The mortality rates are around 20-30% or higher in highly severe cases. In addition to losses due to mortality, producers lose money due to poor growth as well as decreased meat yield and quality. Additionally, the birds get more susceptible to secondary infections, e.g., necrotic enteritis ([Moore, 2016](#)).

The costs caused by coccidiosis in poultry are about 13 billion US \$ ([Blake, 2020](#)). These costs globally divide into 1 billion costs for prophylaxis/treatment and 12 billion due to performance losses. Until now, only 5% of the prophylaxis costs have been created by natural solutions. That means that there is still a high potential to be tapped.

Natural solutions, unfortunately, are only used by a minority

For a long time, ionophores fitting the classical definition of antibiotics and chemicals were used in coccidia-fighting programs – and contributed to the development of antimicrobial resistance ([Nesse et al., 2015](#)). Nowadays, the combination with vaccination in rotation or shuttle programs has reduced this danger, but there is still potential. Meanwhile, some natural solutions are available that can be integrated into coccidiosis-fighting programs. However, producers using natural solutions are still a minority.

For thousands of years, plants have been used in human and veterinary medicine. Before the discovery of antibiotics in 1928, diseases were fought with plants. To regain the effectiveness of antibiotics, using natural solutions for prophylaxis should be once more standard, and the use of antibiotics is the treatment only for critical cases.

How does Eimeria damage broilers

The pathogenic mechanism of coccidia or *Eimeria* spp. is mainly the massive destruction of host intestinal cells when it reproduces, resulting in severe damage to the intestinal mucosa. On the one hand, the damaged gut wall loses its capability for effective digestion and absorption of nutrients, leading to worse feed conversion and lower weight gain.

On the other hand, this damage reduces the chicken's immunity and paves the way for other infections, such as necrotic enteritis, and raises mortality.

Table 1: The seven most known *Eimeria* species in broilers and their main site of occurrence

Eimeria species	Predilection site
<i>E. tenella</i>	Ceca
<i>E. acervulina</i>	Duodenum and prox. jejunum
<i>E. maxima</i>	Central jejunum
<i>E. mitis</i>	Distal jejunum and ileum
<i>E. necatrix</i>	Central jejunum and ceca
<i>E. brunetti</i>	Ileum, entrance of the ceca and rectum
<i>E. praecox</i>	Duodenum and prox. jejunum

Concerning their pathogenicity, for poultry, the *Eimeria* species must be ordered in the following way: *E. necatrix* > *E. tenella* > *E. brunetti* > *E. maxima* > *E. acervulina* > *Eimeria mitis*, and *Eimeria praecox*.

Prevention is better than treatment

Thanks to its bi-layered wall with a robust structure, the oocysts of coccidia are extremely resilient. They can survive 4 to 9 months in the litter or soil and are resistant to common disinfectants. Farm personnel and visitors are also important vectors, so good biosecurity practices can reduce the number of oocysts contaminating the premises and help prevent clinical outbreaks. Coccidiosis control in poultry should focus on “prevention” rather than “treatment”, combining biosecurity practices, feed additives, and/or vaccination.

Effective hygiene on the farm is crucial

To prevent coccidia infections, one of the most critical points is hygiene. Biosecurity practices are crucial and include cleaning and disinfection of the poultry houses and their surroundings, pest control and prevention, restriction, control, and management of the entry of personnel, visitors, vehicles, and equipment, among others.

Coccidia oocysts are ubiquitous and survive for a long time, and even effective cleaning and disinfection cannot completely remove them. After a severe outbreak, it is recommended to take drastic biosecurity measures such as flame or caustic soda disinfection to prevent further spread of the disease.

When there are birds in the house, it must be paid attention that the litter is not excessively humid. Litter moisture should be maintained around 25%; turning and replacing moist litter are the best practices to follow. For keeping the litter dry, adequate ventilation and appropriate stocking density are beneficial.

To avoid unnecessary stress and gut health issues, the birds must be fed according to their requirements with high-quality feed so that the animals build up good immunity and resilience.

Coccidiosis can be controlled with effective programs

Anticoccidial drugs were the first means of preventing and controlling coccidiosis in chickens and once achieved very good results. Since Sulfaquinoxaline was found to be effective in the 1850s, about fifty other drugs have been developed for the prevention and control of coccidiosis. Generally, the [anticoccidials](#) used for years to prevent the disease can be divided into ionophores and chemicals.

Ionophores, produced as by-products of bacterial fermentation, are technically antibiotics. The great benefits of ionophores are that they kill the parasite before it can infect the bird and thus prevent damage to the host cells. *Eimeria* species also take a long time to develop resistance to ionophores ([Chapman, 2015](#)). Well-established ionophores are products that contain monensin, lasalocid, salinomycin, narasin, or maduramycin; the trade names are Coban/Monensin, Avatec, Coxisstac, Monteban, and Cygro.

Chemicals, these molecules, are produced by chemical synthesis. They differ from each other and ionophores as each one has a unique mode of action against coccidia. In general, they act by interfering with one or more stages of the life cycle of *Eimeria*, e.g., supplying fake nutrients (Amprolium, Vit. B1) to the parasite, starving them out. The active components here are nicarbazin, amprolium, zoalene, decoquinate, clodolol, robenidine and diclazuril, and the respective trade names Nicarb, Amprol, Zoamix, Deccox, Coyden, Robenz and Clinacox. *Eimeria* species develop resistance to these chemical molecules; therefore, they must be used carefully and with strict planning. However, cross-resistance does not develop, making them highly valuable in rotation programs.

Vaccination against coccidiosis is accepted by many farmers as a good solution to control coccidiosis in chickens. Vaccination aims to replace resistant field strains with vaccine strains, which are sensitive to anticoccidials. Currently, commercial chicken vaccines are available in natural and attenuated strains; research to obtain safer and more efficient vaccines is also ongoing.

Non-attenuated vaccines are less expensive and make for good immunity, but as they may mildly damage the intestinal epithelium, the risk of necrotic enteritis can increase. On the contrary, attenuated strains – usually “precocious” strains with shorter reproduction cycles, cause less intestinal damage and thus have a lower risk of provoking bacterial or necrotic enteritis. The immunity is like after normal infections; however, you have a controlled epidemiology, fewer coccidiosis outbreaks, and an improved uniformity of the flock.

Phytomolecules-based natural anticoccidials saponins and tannins are natural components that can also help control coccidiosis (e.g., [Prelect D, EW Nutrition GmbH](#)). These ingredients act in different ways: the tannins improve the intestinal barrier function locally and systemically. The saponins directly impact the oocysts by preventing their growth, interacting with the cholesterol in the cell membrane (triterpenoid saponin), or hindering further sporulation and causing cell death by causing pores in the cell membrane of the parasite. Altogether, Prelect D promotes the beneficial microbial population and reduces the harmful one, improves the gut barrier function, reduces mucosal inflammation, inhibits growth and replication of *Eimeria*, preventing their lesions, and fosters birds’ immune response against *Eimeria* spp.

To prove Prelect D’s effectiveness in the reduction of coccidiosis, several trials were conducted. One of the trials was carried out in Poland with 360.000 broilers in commercial conditions. The animals were divided into ten houses, and two cycles were tested. Half of the birds served as control and received Narasin and Nicarbazin in the starter and grower I diet and salinomycin in the grower II diet. The other half also were fed Narasin and Nicarbazin in the starter and grower I diet, but Prelect D @1kg/t in grower II and 0.5kg/t in the finisher diet. The results are shown in figure 1: The application of Prelect D in the grower II and finisher diet decreased the number of oocysts in the droppings more than the application of salinomycin and, therefore, reduced the spreading of coccidiosis. In addition, the performance of the broilers receiving Prelect D was nothing short of the control’s performance showing Prelect as an optimal completion in shuttle or rotation programs (see more [HERE](#)).

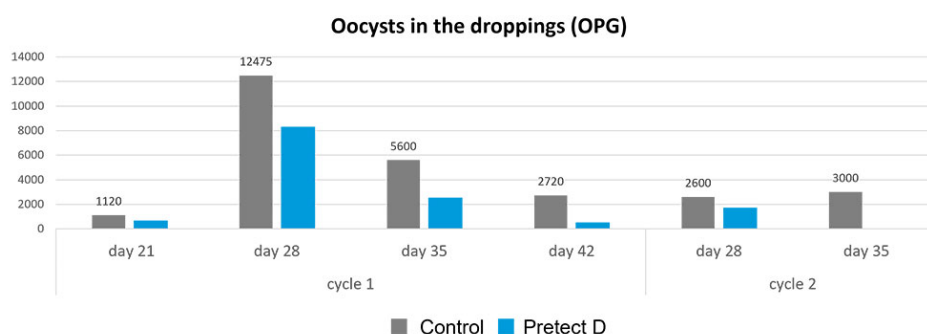


Figure 1: Reduction of oocysts in the droppings by Prelect D

Managing coccidiosis without promoting

antimicrobial resistance is not easy, but feasible

Coccidiosis is a challenge aggravated by our current high level of production. Tools such as ionophores, chemicals, but also vaccines, and natural products are available to fight coccidiosis. However, due to the high probability of resistance development, these tools must be used carefully and in structured programs. The phytomolecules-based product Prelect D gives the possibility to reduce antimicrobial resistance as part of programs against coccidiosis.

References upon request

Pathogenic *Enterococcus cecorum* - an emerging profit killer for broiler producers



By **Dr. Ajay Bhojar**, Global Technical Manager, EW Nutrition

Pathogenic *Enterococcus cecorum* (EC) is emerging as a significant challenge in poultry production worldwide, causing substantial losses to commercial flocks. EC has become a considerable concern for the poultry industry, not only because of its rapid spread and negative impact on broiler health but also because of its increasing antibiotic resistance. As a result, there is a growing need to explore alternative ways of controlling this bacterium. There is no silver bullet yet as a replacement for antibiotics to limit the load of *E. cecorum*. Maintaining optimum gut health to avoid *E. cecorum* leakage during the first week of the broiler's life can control losses due to *E. cecorum*.

Phytochemical compounds, which are derived from plants, have gained attention in the last decades as a

potential solution for controlling common gut pathogens. These natural compounds have been found to possess antimicrobial properties and can help improve gut health in broilers. In this article, we will discuss the current state of *E. cecorum* and explore potential strategies, including using phytochemicals as support in controlling economic losses due to this emerging pathogen in broiler production.

Enterococcus cecorum and its negative impact on broiler production

E. cecorum is a component of normal enterococcal microbiota in the gastrointestinal tract of poultry. These are facultatively anaerobic, gram-positive cocci. Over the past 15 years, pathogenic strains of *E. cecorum* have emerged as an important cause of skeletal disease in broiler and broiler breeder chickens (Broast et al., 2017; Jackson et al., 2004 and Jung et al., 2017). Along with the commensal strains of EC, the pathogenic strains also occur and can result in Enterococcal spondylitis (ES), also known as “kinky back”, a serious disease of commercial poultry production in which the bacteria translocate from the intestine to the free thoracic vertebrae and adjacent notarium or synsacrum, causing lameness, hind-limb paresis and, in 5 to 15% of cases, mortality (de Herdt et al., 2008; Martin et al., 2011; Jung and Rautenschlein, 2014). The compression of the spinal cord due to infection of the free thoracic vertebra results in the so-called “kinky back” in the skeletal phase of *E. cecorum* infection. Kinky back is also a common name for spondylolisthesis, a developmental spinal anomaly. EC is normally found in the gastrointestinal tract and may need the help of other factors, such as a leaky gut, to escape the gastrointestinal tract. The emergent pathogenic strains of *E. cecorum* have developed an array of virulence factors that allow these strains to 1) colonize the gut of birds in the early life period; 2) escape the gut niche; 3) spread systemically while evading the immune system; and 4) colonize the damaged cartilage of the free thoracic vertebra (Borst, 2023). The *E. cecorum* can invade internal organs and produce lesions in the pericardium, lung, liver, and spleen.

The negative impact of *E. cecorum* on broiler economics, health, and welfare

Enterococcus cecorum can harm broiler health, welfare, and economics. This can result in decreased profitability for broiler producers.

The broiler flocks infected with *E. cecorum* may have reduced feed intake/ nutrient absorption and reduced growth rates, leading to a higher feed conversion ratio, longer production cycles, and lower weight gain. The morbidity and mortality from *E. cecorum* infection can be as high as 35 % and 15%, respectively. The higher condemnations of up to 9.75% at the processing plant can further add to the losses (Jung et al., 2018). This can result in significant economic losses for producers.

Further, *E. cecorum* infections can impair the immune function of broilers, making them more susceptible to other pathogens and reducing their overall health and welfare. Pathogenic *E. cecorum* is an opportunistic pathogen that can gain momentum during coinfection with *E. coli* and other gut pathogens, causing a leaky gut. Therefore, a holistic approach to gut health management may help reduce the losses.



Antibiotic resistance in *E. cecorum*

E. cecorum has been found to be resistant to multiple antibiotics. Multidrug resistant pathogenic *E. cecorum* could be recovered from lesions in whole birds for sale at local grocery stores (Suyemoto et al., 2017). Antibiotic resistance can make it difficult to treat and control infections in broilers. This can lead to increased use of multiple antibiotics, which can contribute to the development of antibiotic-resistant bacteria and pose a risk to human health.

Transmission of *E. cecorum* in broiler flocks

Despite the rapid global emergence of this pathogen, and several works on the subject, the mechanism by which pathogenic *E. cecorum* spreads within and among vertically integrated broiler production systems remains unclear (Jung et. al.2018). The role of vertical transmission of pathogenic *E. cecorum* remains elusive. Experimentally infected broiler breeders apparently do not pass the bacterium into their eggs or embryos (Thoefner and Peter, 2016). However, it has been noted that a very low frequency of infected chicks can cause a flock-wide outbreak.

Horizontal transmission: *E. cecorum* can be transmitted between birds within a flock through direct contact or exposure to contaminated feces, feed, or water.

While the mode of transmission between flocks has not been definitively identified, pathogenic *E. cecorum* demonstrates rapid horizontal transmission within flocks. It can spread rapidly within flocks via fecal-oral transmission.

Personnel and equipment: *E. cecorum* can be introduced into a flock through personnel or equipment that has been in contact with infected birds or contaminated materials. For example, personnel working with infected flocks or equipment used in infected flocks can spread the pathogen to uninfected flocks.

Symptoms and diagnosis of *E. cecorum* in broilers

Enterococcus cecorum infections in broilers can present a range of symptoms, from mild to severe. The most common symptom noticed with *E. cecorum* is paralysis, which is due to an inflammatory mass that develops in the spinal column at the level of the free thoracic vertebra (FTV). Recognition of this spinal lesion has given rise to several disease names for pathogenic *E. cecorum* infection, which include vertebral osteomyelitis, vertebral enterococcal osteomyelitis and arthritis, enterococcal spondylitis (ES), spondylolisthesis and, colloquially, “kinky-back” (Jung et al. 2018).

E. cecorum infections can exhibit increased mortality due to septicemia in the early growing period. In this sepsis phase, the clinical signs of *E. cecorum* may include fibrinous pericarditis, perihepatitis, and airsacculitis. These lesions might be confused with other systemic bacterial infections like colibacillosis. Therefore, a pure culture is needed for the correct diagnosis of *E. cecorum*.

The second phase of mortality due to dehydration and starvation of the paralyzed birds can be observed during the finisher phase peaking during 5-6 weeks of age. Paralysis from infection of the free thoracic vertebra is the most striking feature of this disease, with affected birds exhibiting a classic sitting position with both legs extended cranially (Brost et al., 2017).

Diagnosis of *E. cecorum* in broilers can be challenging, as the symptoms of infection can be similar to those of other bacterial or viral infections. However, a combination of clinical signs, post-mortem examination, and laboratory testing can help to confirm the presence of *E. cecorum*. Laboratory tests such as bacterial culture and polymerase chain reaction (PCR) can be used to identify the pathogen and also to determine its antibiotic susceptibility. Veterinarians and poultry health professionals can work with producers to develop a diagnostic plan and implement appropriate control measures to manage *E. cecorum* infections in broiler flocks.



Prevention and Control of *Enterococcus cecorum*

The broiler producers/ managers should work with their veterinarians and poultry health professionals to develop an integrated approach to control the spread of *E. cecorum* and prevent its negative impact on broiler health and productivity.

Currently, there is no commercial vaccine available for preventing pathogenic *E. cecorum* infection. Therefore, controlling *Enterococcus cecorum* infection in broiler flocks requires a multifaceted approach that addresses the various modes of transmission and bacterial resistance to antibiotics.

Implementing strict biosecurity protocols, such as controlling access to the farm, disinfecting equipment and facilities, and implementing proper hygiene protocols throughout the integrated broiler operation, can help to minimize the risk of transmission.

Thorough washing of trays and chick boxes in the hatchery with hot water (60-62°C) mixed with an effective disinfectant can reduce the possible vertical transmission of *E. cecorum*. The vertical transmission may also be prevented by adopting the practice of separating the dirty floor eggs from clean hatching eggs and setting them in the lower racks of the incubator.

Generally, pathogenic isolates from poultry were found to be significantly more drug-resistant than commensal strains (Borst et al., 2012). The selection of an effective antibiotic for the treatment of *E. cecorum* should be made based on the results of the antibiotic sensitivity test. Antibiotic therapy may not help with paralyzed birds, which ultimately need to be culled. Reducing the use of antibiotics and implementing prudent use practices can help to reduce the development of antibiotic resistance in *E. cecorum* and other bacteria.

Probiotics can help to maintain the balance of the gut microbiota and may have a protective effect against *E. cecorum* infections. Fernandez et al. (2019) reported the inhibitory activities of proprietary poultry *Bacillus* strains against pathogenic isolates of *E. cecorum* in vitro, but effects are highly strain-dependent and vary significantly among different pathogenic isolates.

Phytogenic compounds and organic acids have been shown to have antimicrobial properties. Phytomolecule-based preparations may help to control *E. cecorum* infections in broiler flocks in the first week of life, reducing the chances of its translocation from the intestine.

Phytomolecules-based liquid formulations for on-farm drinking water application can also be a handy tool to manage gut health challenges, especially during risk periods in the life of broilers. Such liquid phytomolecule preparations can help to quickly achieve the desired concentration of the active ingredients for a faster antimicrobial effect.

However, these alternatives to antibiotics may be effective only when the *E. cecorum* is still localized within the gut during the first two weeks of the broiler chicken's life.

Phytomolecules, also known as phytochemicals, are naturally occurring plant compounds that have been found to have antimicrobial properties. Especially for commercial poultry, nutraceuticals such as phytochemicals showed promising effects, improving the intestinal microbial balance, metabolism, and integrity of the gut due to their antioxidant, anti-inflammatory, immune modulating, and bactericidal properties (Estevez, 2015). Phytogenic compounds have been studied for their potential use in controlling gut pathogens in poultry. Here are some of the roles that phytomolecules can play in controlling gut pathogens:

Antimicrobial activity: Several phytomolecules, such as essential oils, flavonoids, and tannins, have been found to have antimicrobial activity. Hovorková et al (2018) studied the inhibitory effects of hydrolyzed plant oils (palm, red palm, palm kernel, coconut, babassu, murumuru, tucuma, and Cuphea oil) containing medium-chain fatty acids (MCFAs) against Gram-positive pathogenic and beneficial bacteria. They concluded that all the hydrolyzed oils were active against all tested bacteria (*Clostridium perfringens*, *Enterococcus cecorum*, *Listeria monocytogenes*, and *Staphylococcus aureus*), at 0.14–4.5 mg/ml, the same oils did not show any effect on commensal bacteria (*Bifidobacterium* spp. and *Lactobacillus* spp.). However, further research is needed to test the in-vivo efficacy of phytogenic compounds against pathogenic *E. cecorum* infections in poultry.

Anti-inflammatory activity: The other coinfecting gut pathogens of *E. cecorum* can cause inflammation

in the intestinal tract of poultry. This can lead to reduced feed intake and growth. Some phytochemicals have been found to have anti-inflammatory activity and can reduce the severity of inflammation. Capsaicin, a naturally occurring bioactive compound in chili peppers, was found to have antioxidant and anti-inflammatory activity. The tendency of capsaicin to substantially diminish the release of COX-2 mRNA is thought to be the reason for its anti-inflammatory effects (Liu et al., 2021). Thyme oil reduced the synthesis and gene expression of TNF- α , IL-1B, and IL-6 in activated macrophages in a dose-dependent manner, with upregulation of IL-10 secretion (Osana and Reglero, 2012). Cinnamaldehyde has been shown to decrease the expression of several cytokines, such as IL-1 β , IL-6, and TNF- α , as well as iNOS and COX-2, in in-vitro studies (Pannee et al., 2014).

Antioxidant activity: Oxidative stress may contribute to the development of *E. cecorum* infections in poultry. Phytochemicals, such as polyphenols and carotenoids, have been found to have antioxidant activity and can reduce oxidative stress in the gut of poultry, which can help to prevent *E. cecorum* infections. Polyphenols widely exist in a variety of plants and have been used for various purposes because of their strong antioxidant ability (Crozier et al., 2009). Quercetin, a flavonoid compound widely present in vegetables and fruits, is well-known for its potent antioxidant effects (Saeed et al., 2017).

Phytochemicals can also modulate the immune system of poultry, which can help to prevent *E. cecorum* infections. For example, some flavonoids and polysaccharides have been found to enhance the immune response of poultry. Fahnani et. al. (2019) found that supplementing broiler chickens with a combination of flavonoids and polysaccharides extracted from the mushroom *Agaricus blazei* enhanced their immune response.

Overall, [phytochemicals](#) have shown promise in supporting the optimum gut health of poultry. Many phytochemical preparations available in the market can be regarded as an important tool to reduce the use of antibiotics in animal production and mitigate the risk of antimicrobial resistance. However, more research is needed to develop an effective combination of active ingredients, as well as strategies for their use in controlling *E. cecorum* infections in poultry.

Conclusion

In conclusion, the emergence of pathogenic strains of *E. cecorum* is becoming a major concern for broiler producers globally. This bacterial pathogen can cause significant economic losses in the broiler industry by affecting the overall health and productivity of the birds. Pathogenic *E. cecorum* infection can lead to clinical signs including diarrhea, decreased feed intake, reduced growth rate, and increased mortality. Proactive measures must be taken to prevent the introduction and spread of pathogenic *E. cecorum* in broiler flocks. Implementing strict biosecurity protocols and proper disinfection procedures can help reduce the risk of *E. cecorum* infection. The use of effective antibiotics after receiving the results of the antibiotics sensitivity test is a crucial step in controlling the infection. Phytochemical-based preparations can be a potential alternative to control the load of *E. cecorum* by maintaining optimum gut health to minimize economic losses. Moreover, ongoing surveillance and monitoring of pathogenic *E. cecorum* prevalence in the broiler industry can assist in the timely detection and control of outbreaks.

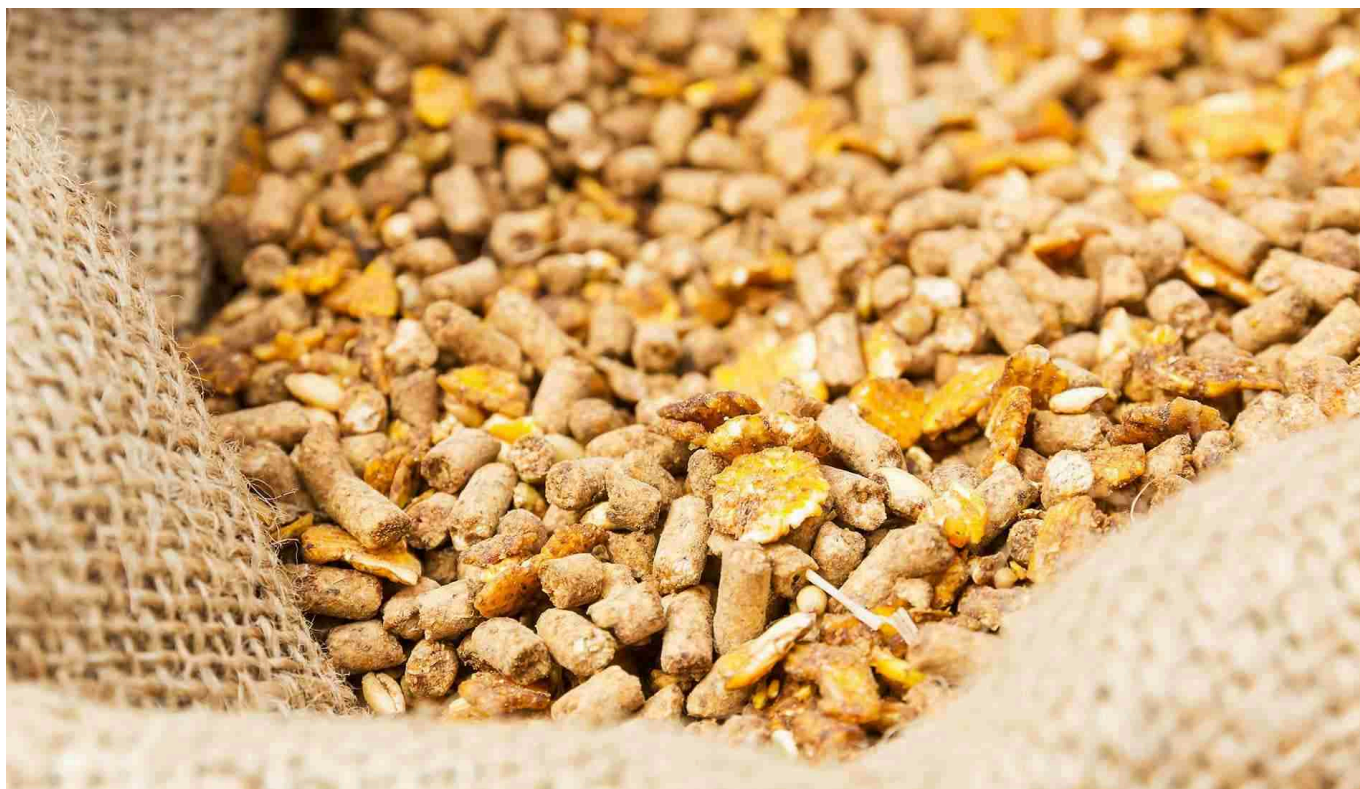
In summary, the emergence of pathogenic *E. Cecorum* as a profit killer in the broiler industry warrants careful attention and proactive management practices to minimize its impact.

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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 phytochemicals 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 phytochemicals competitor feed supplements.

For this trial, feed with the different added phytochemical feed supplements had to undergo a conditioning and pelletization process. The active ingredients were analyzed before and after the pelletization process. All phytochemical 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.

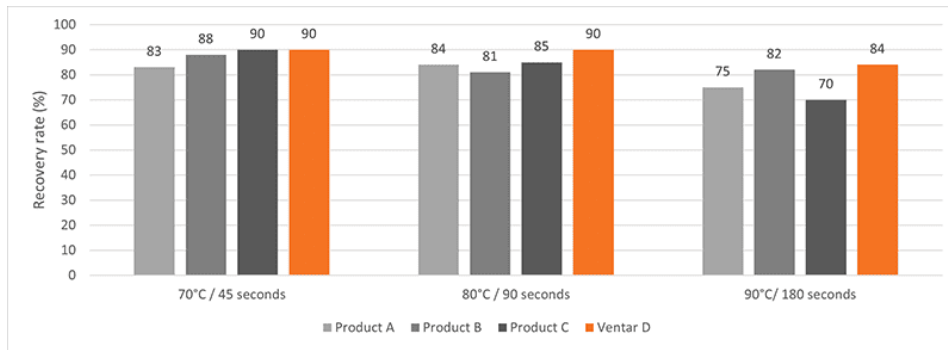


Figure 1: Phytomolecule stability under processing conditions, relative to mash baseline (100%)

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.

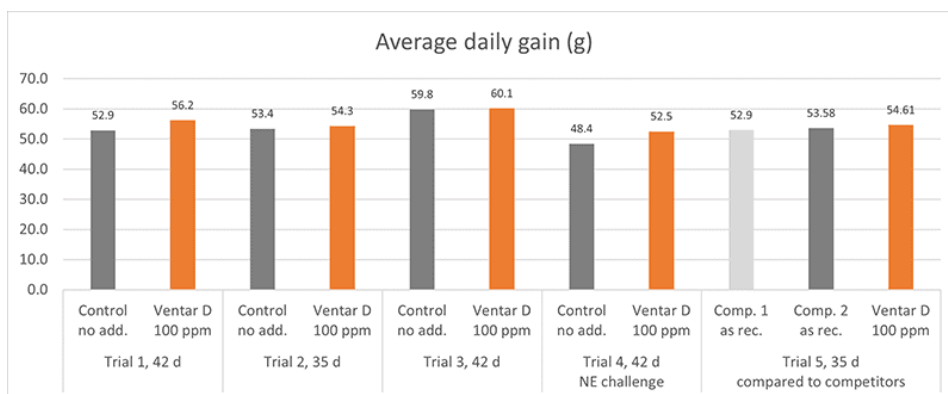


Figure 2: Average daily gain (g) – results of several trials conducted with broilers

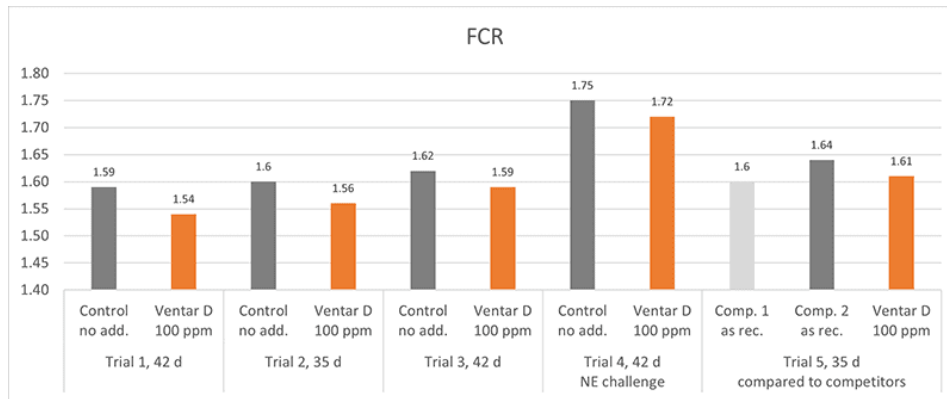


Figure 3: FCR – results of several trials conducted with broilers

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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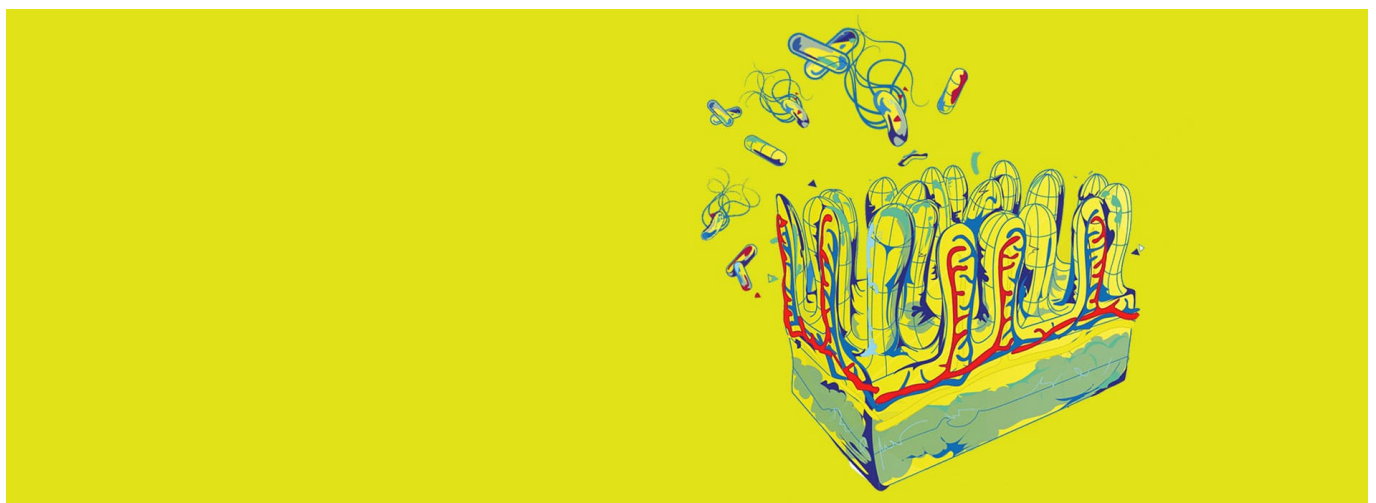
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Efficient microbiome modulation with phytomolecules



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

From day 1, young animals are confronted with the pathogens of their environment. Feed and feed ingredients also significantly increase exposure to microbes. This article will look closely at three critical bacteria in poultry production. The trials of phytomolecules-based products shared in this article prove the unique benefit of lowering harmful pathogens while

simultaneously sparing health-promoting microbes. The targeted selection of the blend's phytomolecules contributes to this distinctive mode of action.

***E. coli* can be valuable... and dangerous**

E. coli are commensal bacteria that usually belong to the natural gut flora. However, there are several *E. coli* strains that, due to certain virulence factors, can cause disease. These bacteria are called avian pathogenic *E. coli* or APEC. The disease 'Colibacillosis' can occur in different forms:

- Omphalitis - a noncontagious infection of the navel and/or yolk sac in young poultry
- peritonitis - inflammatory response on "internal laying" (yolk material in the peritoneum)
- salpingitis - inflammation of the oviduct
- cellulitis - discoloration and thickening of the skin, inflammation of the subcutaneous tissues
- synovitis - lameness with swollen joints
- coligranuloma (Hjärre disease) - lesions similar to tuberculosis, not of economic importance
- meningitis, and
- septicemia or blood poisoning.

Since some of the *E. coli* strains can sometimes be transmitted vertically to offspring, it is crucial to keep the pathogenic pressure in the parent generation as low as possible ([Mc Dougal, 2018](#)).

Due to the, mostly in young chicks, common use of antibiotics, *E. coli* strains resistant to β -lactam antibiotics (ESBL-producing *E. coli*) or fluoroquinolones (e.g., Enrofloxacin) have developed.

Clostridium perfringens: the cause of necrotic enteritis

Clostridium perfringens belong to the normal caecal flora. However, its overgrowth in the intestine is linked to [necrotic enteritis](#), causing estimated losses of up to USD 6 billion yearly in global poultry production, which corresponds to USD 0.0625 per bird ([Wade and Keyburn, 2015](#)). Necrotic enteritis can occur in a clinical and a subclinical form.

In the case of clinical necrotic enteritis, the birds suffer from diarrhea resulting in wet litter and increased flock mortality of up to 1 % per day (Ducatelle and Van Immerseel, 2010). Mortality rates sometimes sum up to 50 % (Van der Sluis, 2013). If birds die without clinical signs, it may be peracute necrotic enteritis.

The subclinical version, however, is more critical. Due to the lack of symptoms, it often remains undetected and, therefore, not treated. Mainly through the impaired utilization of feed, representing 65-75 % of the total costs in broiler production, subclinical necrotic enteritis permanently impacts production efficiency ([Heinzel et al., 2020](#)).

Salmonella enterica: a zoonosis relevant for birds and humans

Most concerning in (non-typhoid) salmonellosis is that it can be transferred to humans. The transmission occurs via direct contact with an infected animal, consuming contaminated animal products such as meat or eggs, contact with infected vectors (insects or pets) or contaminated equipment, or cross-contamination in the kitchen. Frozen or raw chicken products, as well as the eggs, are frequent causes of animal-origin *Salmonella* infections in humans.

Salmonella is the more critical the younger the birds. If the hatching eggs already carry salmonellae, the hatchability dwindles. During their first weeks of life, infected chicks show higher mortality and systemic

infections.

Adult animals usually do not die from salmonellosis; often, the infection remains unnoticed. During an acute salmonella outbreak, the animals might show weakness and diarrhea. They lose weight, resulting in decreased egg production in layers.

Trials with phytomolecules show promising results

To check if phytomolecules-based products can effectively influence gut flora, a product specially designed for gut health ([Ventar D](#)) was tested for its antimicrobial activity. Additionally, the extent to which the same blend impacted the beneficial bacteria, such as Lactobacilli, was evaluated.

Trial 1: phytomolecules act against *E. coli* and *Salmonella enterica*

The in vitro study using the agar dilution method was conducted at a German laboratory.

The bacteria (*Salmonella typhimurium* and ESBL-producing *E. coli*) stored at -80°C were reactivated by cultivating them on Agar Mueller Hinton overnight. After this incubation, some colonies were picked and suspended in 1 ml 0.9% NaCl solution. 100 μl of the suspension were pipetted and evenly spread (plate spread technique) on new Agar Mueller Hinton containing different concentrations of a phytomolecules-based product (Ventar D): 0 $\mu\text{g}/\text{mL}$ - control; 500 $\mu\text{g}/\text{mL}$; 900 $\mu\text{g}/\text{mL}$; 1.250 $\mu\text{g}/\text{mL}$ and 2.500 $\mu\text{g}/\text{mL}$. After 16-20 h incubation at 37°C , growth was evaluated. The results can be seen in pictures 1 and 2:

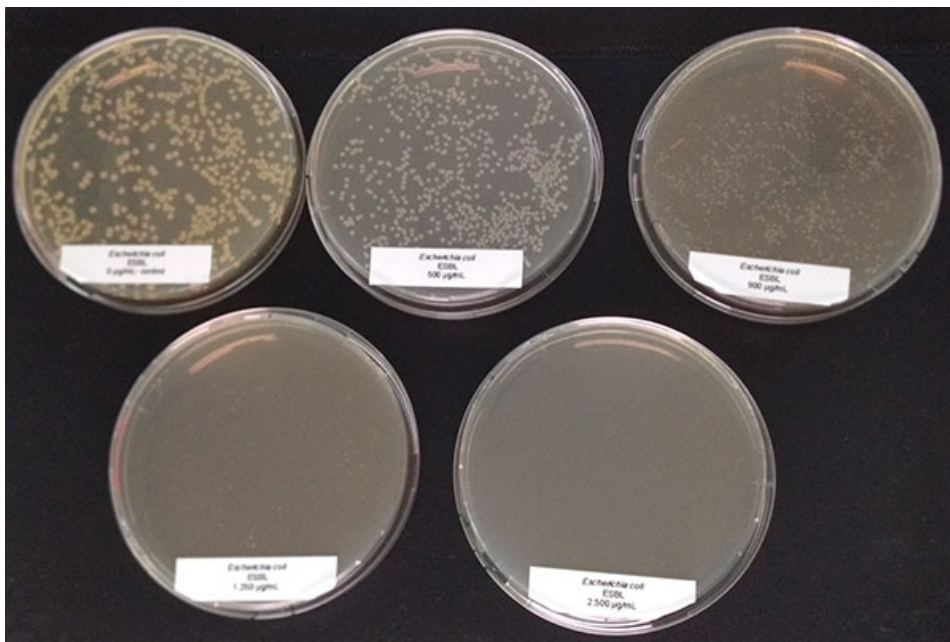


Figure 1: *E. coli* exposed to different concentrations of Ventar D (upper row from left to right: control 0 $\mu\text{g}/\text{ml}$, 500 $\mu\text{g}/\text{ml}$, 900 $\mu\text{g}/\text{ml}$; lower row from left to right: 1250 $\mu\text{g}/\text{ml}$ and 2500 $\mu\text{g}/\text{ml}$)

E. coli colonies exposed to 900 $\mu\text{g}/\text{mL}$ of Ventar D's phytogetic formulation were smaller than the control colonies. At 1250 $\mu\text{g}/\text{mL}$, fewer colonies were detected, and at 2500 $\mu\text{g}/\text{mL}$, growth couldn't be seen anymore.

The salmonella colonies showed a similar picture; however, the reduction could be seen from a concentration of 1.250 $\mu\text{g}/\text{ml}$ of Ventar D onwards (picture 2).

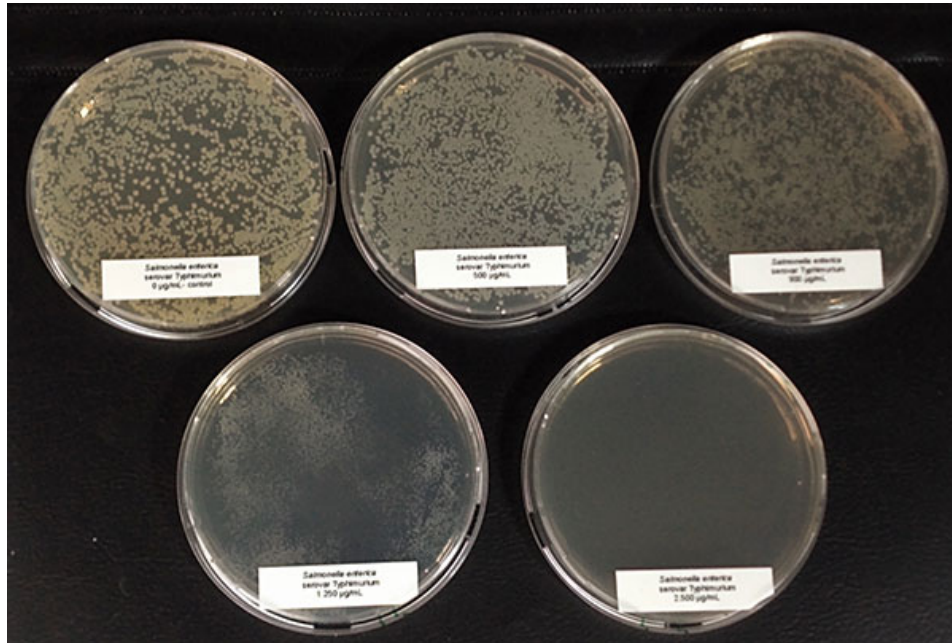


Figure 2: *Salmonella enterica* exposed to different concentrations of Ventar D (upper row from left to right: control 0 µg/ml, 500 µg/ml, 900 µg/ml; lower row from left to right: 1250 µg/ml and 2500 µg/ml)

Trial 2: Phytomolecules inhibit *Clostridium perfringens* and spare *Lactobacilli*

In this trial, the bacteria (*Clostridium perfringens*, *Lactobacillus agilis* S73, and *Lactobacillus plantarum*) were cultured under favorable conditions (RCM, 37°C, anaerobe for *Clostr. perfr.*, and MRS, 37°C, 5 % CO₂ for *Lactobacilli*) and exposed to different concentrations of Ventar D (0 µg/ml - control, 500 µg/ml, 750 µg/ml, and 1000 µg/ml).

The results are shown in figures 3a-d.

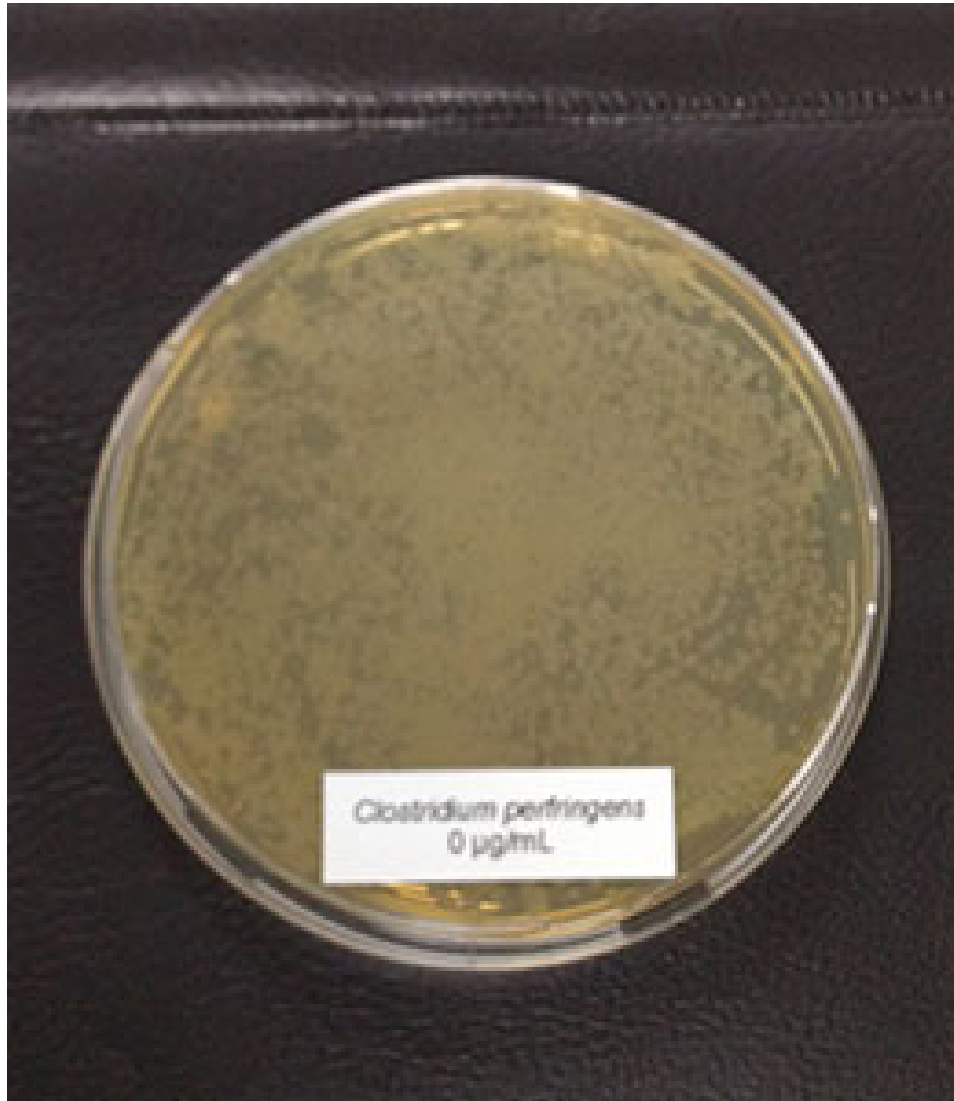


Figure 3a: control, 0 µg/ml

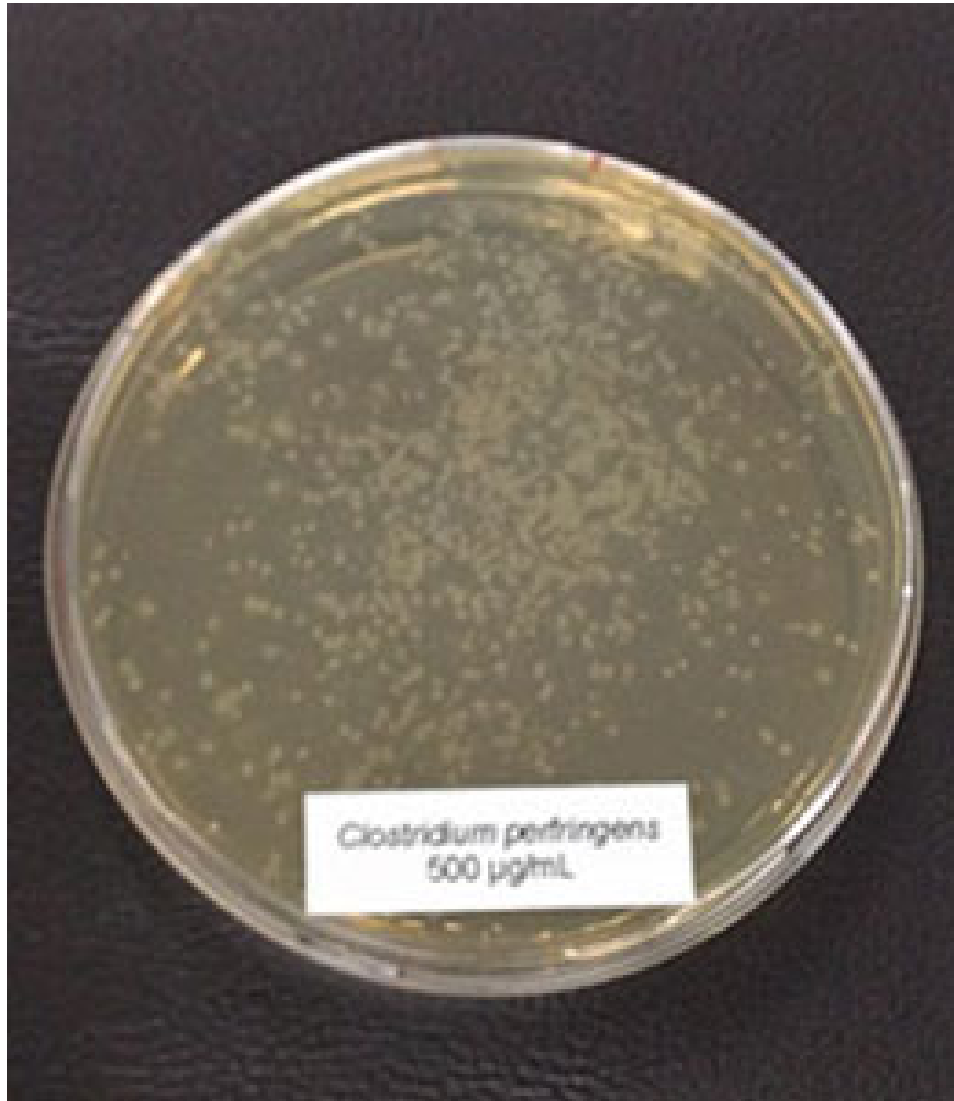


Figure 3b: 500 µg/ml



Figure 3c: 750 µg/ml

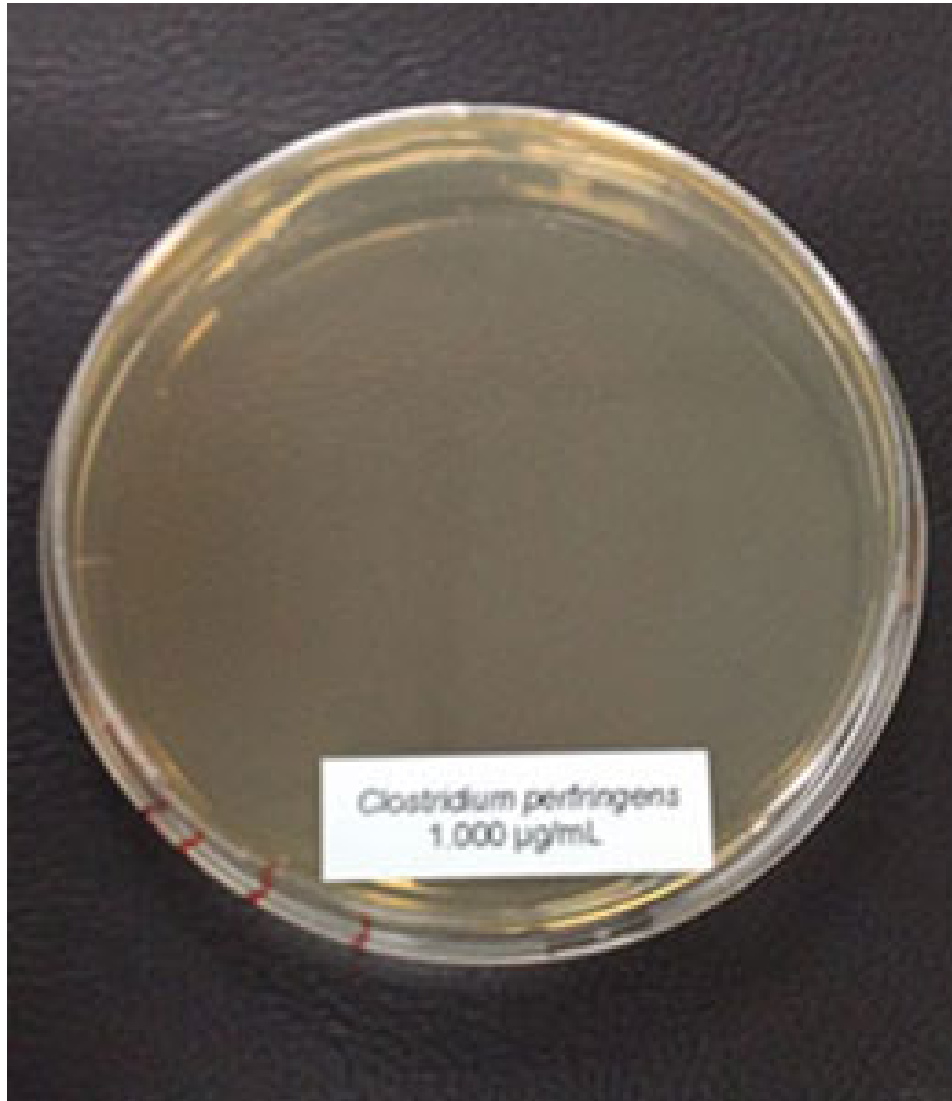


Figure 3d: 1000 µg/m

In the case of *Clostridium perfringens*, a significant reduction of colonies could already be observed at a concentration of 500 µg/ml of Ventar D. At 750 µg/ml, only a few colonies remained. At a Ventar D concentration of 1000 µg/ml, *Clostridium perfringens* could no longer grow.

In contrast to *Clostridium*, the *Lactobacilli* showed a different picture: only at the higher concentration (1250 µg/ml of Ventar D), *Lactobacillus plantarum* and *Lactobacillus agilis* S73 showed a slight growth reduction (figures 4 and 5).

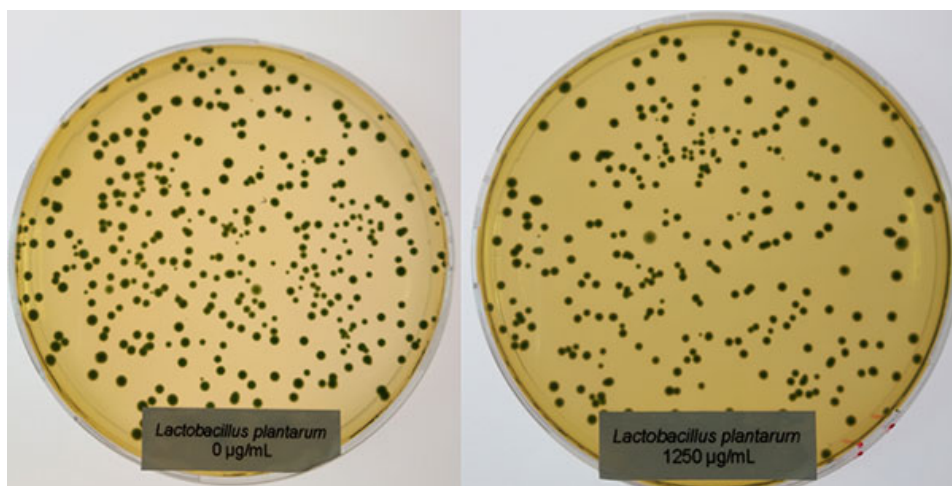


Figure 4: *Lactobacillus plantarum* exposed to 0 (left) and 1250 $\mu\text{g/ml}$ (right) of Ventar D

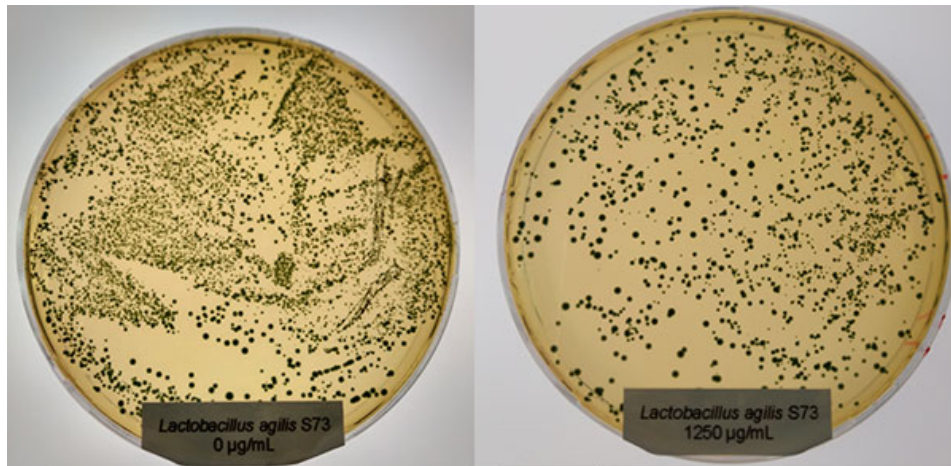


Figure 5: *Lactobacillus agilis S73* exposed to 0 (left) and 1250 $\mu\text{g/ml}$ (right) of Ventar D

Improve gut health by positively influencing the intestinal flora

The experiments show that even at lower concentrations, phytochemicals impair the growth of harmful bacteria while sparing the beneficial ones. Phytochemical-based products can be regarded as a valuable tool for controlling relevant pathogens in poultry and influencing the microflora composition in a positive way.

The resulting better gut health is the best precondition to reducing antibiotics in animal production.