# Climate change in poultry production: 5 major threats and what you can do to mitigate the impact

"Every single social and global issue of our day is a business opportunity in disguise."
*Peter Drucker*

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



Global livestock systems constitute an industrial asset worth over $1.4 trillion. Projections indicate that the global livestock population, now at 60+ billion, could exceed 100 billion by 2050 – more than ten times the expected human population at that time (Yitbarek 2019, Herrero 2009).

Our industry bears an enormous responsibility: to feed the growing population, sustainably and consistently, despite increasing challenges. And one of the biggest challenges is already looming large.

Animal agriculture, including poultry farming, is particularly susceptible to the adverse effects of climate change. Increased extreme weather events, farm fires facilitated by drought, thermal pressure on farmed animals, reduced availability or increased prices of water, raw materials, and electricity, and much more are already impacting the industry.

This is, in all likelihood, just the beginning. How exactly will poultry production be affected in the future – and what can you do to future-proof your operation against the coming challenges?

# Major impact areas of climate change – and what to do about them

## 1. Feed quality

Excessive heat, droughts, or floods can reduce crop yields, decrease nutritional content, and increase the risk of pests, pathogens, and weed outbreaks.

Plants with a $C_3$ photosynthetic pathway such as wheat, rice, or soybean can benefit from increased temperature more than the so-called $C_4$ plants such as corn or sorghum (Cui 2021). NASA projections show corn crop yields are expected to decline 24% in the next 30 years (Gray 2021).

Moreover, increased temperature, shifts in rainfall patterns, and elevated surface greenhouse gas (GHG) concentrations can also lead to lower grain protein concentration (Godde 2010, Myers 2014), as well as affect mineral and vitamin concentrations in plants.

Pollinator-dependent crops like soybean or rapeseed could also see decreased yield under climactic challenges (Godde 2020).

**Fast fact**

In 2020, 75% of soil in Mexico was declared too dry to cultivate crops. In 2021, 70% of the country was impacted by crop loss and water shortages caused by drought. Corn yield decreased by 18% in five years and is expected to fall further (Carlin 2023).

Warmer temperatures and changes in precipitation patterns can create favorable conditions for the growth of mycotoxins, leading to reduced feed quality and health problems in poultry. Especially corn and sorghum are vulnerable to aflatoxin contamination in hot and humid conditions. On top of this, storage will become more challenging as pathogen growth will further erode feed quality.

### ACTION

- **Diversification of feed sources**: Exploring alternative feed ingredients that are less reliant on climate-sensitive crops can help mitigate the impact of changing weather patterns on feed availability and costs.
- **Mycotoxin mitigation**: Not all toxin mitigation solutions are created equal. Choose standardized toxins mitigation solutions based on their efficacy instead of upfront cost. The products that are regularly tested against undesirable and harmful impurities like dioxins, dioxins-like PCBs and heavy metals.

## 2. Genetics

Rising temperatures may lead to reduced fertility and hatchability, affecting the overall health and reproductive performance of chickens. Extreme heat can also impact the expression of genes related to growth, feed efficiency, and resistance to diseases. As a result, poultry breeders and geneticists face the challenge of developing more heat-tolerant poultry breeds to ensure sustainable production under changing climatic conditions.

## ACTION

- **Genetic selection for thermotolerance**: Breeding programs can focus on developing more heat-tolerant chicken breeds that exhibit improved performance and resilience in challenging climatic conditions. Producers need to pay attention to the specifics of the breed's genetic makeup.

# 3. Farm Management

## 3.1 Solving for thermal comfort: Electricity costs

The thermal comfort of livestock is no longer a concern for tropical zones only. Temperate zones are also seeing sustained increases in ambient temperatures.
High temperatures and prolonged heat waves increase electricity consumption as farmers rely on ventilation, cooling systems, and artificial lighting to maintain optimal conditions for chickens. Consequently, energy costs will rise, impacting the profitability of poultry farms.

## 3.2 Solving for water availability: Resource management

Water scarcity, changing precipitation patterns, and droughts can limit the availability of water resources, affecting poultry farms' water consumption and overall operational efficiency.
The quality of water is also an increasing concern. The UN states that "higher water temperatures and more frequent floods and droughts are projected to exacerbate many forms of water pollution – from sediments to pathogens and pesticides". Reduced raw water quality "can decrease animal water intake, feed intake and health" (Valente-Campos 2019). Especially in Asia and Africa, which have seen massive

increases in floods and droughts, respectively, water scarcity and quality will pose severe issues.

## ACTION

- **Improved farm management practices**: Implementing energy-efficient systems, such as solar power and energy-saving technologies, can reduce electricity consumption and associated costs. Water management techniques, such as rainwater harvesting and efficient irrigation systems, can help mitigate the impact of water scarcity. As always, strict biosecurity will play a critical role.
- **Enhanced ventilation and cooling systems**: Upgrading ventilation systems and implementing efficient cooling mechanisms can alleviate heat stress on chickens, enhancing their overall health and productivity. Regular maintenance and sensor technologies also play an important preventive role.

# 3.3 Built-up and human capital risk

In high-risk areas, machinery, electricity networks, telecommunications, building infrastructure in general can be impacted by extreme weather events, rising sea levels etc. (Nardone 2010).

Labor availability and productivity might, on the other hand, be impacted in many areas. Disease outbreaks, including new strains, as well as decreased air quality, extreme events etc. might in the future contribute to labor shortages. The number of unsafe hot workdays is expected to double by 2050, which will impact especially rural India, sub-Saharan Africa, and Southeast Asia (Carlin 2023).

## ACTION

- **Climate-resilient infrastructure**: Investing in resilient infrastructure, such as elevated coops, flood-resistant buildings, or disease surveillance technology can minimize the risk of incidents from weather events and can support early action against disease pressure. Investments in smart farming can also relieve pressure on labor and improve speed of action.
- **Insurability and loan math**: Any future-looking business needs to work with the likelihood of increased insurance costs and higher insurability requirements. Also, a point will come at which non-resilient infrastructure will not be financed.

# 4. Animal performance

**Fast fact**
Heat stress reduces productivity, impacts fertility, and increases susceptibility to disease. It can also reduce the size of eggs and thickness of eggshells (Godde 2021)

While colder areas will benefit from reduced house heating and ventilation needs, warm areas will be at increased risk. A hot environment "impairs production (growth, meat and milk yield and quality, egg yield, weight, and quality) and reproductive performance, metabolic and health status, and immune response" (Nardone 2010, Ali 2020).
The proliferation of pathogens in warm environments will pose further challenges. Antibiotic resistance from attempts to control these issues will only compound the problem.

Additionally, as mentioned before, changes in weather patterns can impact crop yields, including the availability and affordability of feed ingredients for chickens. Producers will have to reformulate often to match availability, cost, and nutritional value.

## ACTION

- **Stress and pathogenic impact mitigation solutions**: Phytogenic feed additives can support poultry gut health and strengthen the immune response when confronted with stress factors, including heat stress, humid environments, pen density, and pathogen pressure. With the added benefit of reducing dependence on antibiotics and other medication, they can naturally stimulate or support a healthy response to challenges.

# 5. On- and off-farm logistics

Transportation is also affected all along the supply chain, from bringing feed or young stock to the farm to moving livestock to processing facilities and further distribution along the chain. Extreme weather events, such as hurricanes, floods, or heavy snowfall, can lead to power outages and/or disrupt transportation routes and infrastructure, hindering the timely delivery of chicks, feed, and other essential supplies to poultry farms.

In addition to the challenge of transportation, packaging will soon fall under regulatory scrutiny. Sustainability requirements may be national, but compliance will have to follow across borders for any producers eyeing international markets.

## ACTION

- **Data is your friend**: Transportation and logistics data can helps improve efficiency and reduce your environmental impact. Start tracking fuel consumption, carbon emissions, transportation costs, and other relevant metrics to identify areas for optimization.
- **Think globally**: ESG (Environmental, Social and Governance) guidance will become a standard in many important markets, including Europe and the US. Keep an eye on international regulations, especially for your target markets. Their ESG requirements are *your* ESG requirements.

# The world needs more meat

The bad news is that climate change is coming at us fast. Animal agriculture will be among the most heavily impacted. Major adjustments will be needed to mitigate the effects and to embrace the long view.

The good news is that livestock systems remain critical to our growing population. The world population is projected to grow to 9.8 billion by 2050 (UNDESA, 2017). Livestock products (meat, milk and eggs) account for about 30% of the population's protein supply, with large regional variations (FAOSTAT, 2022; Godde et al, 2021).

To answer this growing demand, world meat production is expected to increase by 14% by the end of the decade, compared to current figures (Carlin 2023). The increase in meat demand might be as high as 76% compared to 2005/2007 (Alexandratos 2012).

**Fast fact**

1.5% annual growth in livestock and fish production will result from improvements in per-animal productivity. Poultry will account for over 50% of meat production growth, due to sustained profitability and favorable meat-to-feed price ratio (OECD FAO 2022).

# The cost of doing nothing

We must look at the challenges of climate change, in the words of Peter Drucker, as a business opportunity. As always, those who act early will reap important rewards – not just through market differentiation but through economic resilience.

What awaits those who do not take action?

The United Nations Environment Programme warns of some foreseeable consequences of inaction, most of which can be grouped under three categories:

- **Rising costs**: Cost of decreased performance, increased cost of doing business, carbon taxes
- **Policy restrictions**: Once a few major markets have implemented restrictive labeling, packaging, or production regulations, anyone who wants to operate in these markets is subject to the same restrictions.
- **Reputational risk / Market and investor preferences**: The risk of falling behind or not taking action, in other words the opportunity cost, is hard to quantify until it's too late. Banks and investors may give up on unsustainable financing as soon as consumers and/or regulators show signs of concern. Acting ahead of the curve is also a market positioning win as well as economic win. The market rewards first movers.

The impact of climate change on genetics, farm management, animal performance, farm logistics, and transportation necessitate proactive adaptation and mitigation strategies, in coordination with local and global expertise. Responses will vary depending on geography, production type, and more – but *doing nothing is no longer an option*. By implementing sustainable practices across the board and investing in resilient infrastructure, poultry producers can maintain a robust, high-performing, sustainable production system.

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# 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 |
|---|---|
| E. tenella | Ceca |
| E. acervulina | Duodenum and prox. jejunum |
| E. maxima | Central jejunum |
| E. mitis | Distal jejunum and ileum |
| E. necatrix | Central jejunum and ceca |
| E. brunetti | Ileum, entrance of the ceca and rectum |
| E. praecox | 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 out-brakes. 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, clopidol, 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., Pretect 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, Pretect 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 Pretect 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 Pretect D @1kg/t in grower II and 0.5kg/t in the finisher diet. The results are shown in figure 1: The application of Pretect 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 Pretect D was nothing short of the control's performance showing Pretect as an optimal completion in shuttle or rotation programs (see more HERE).

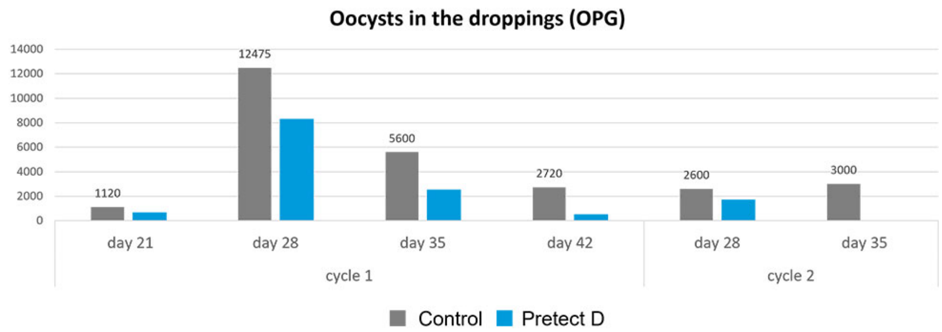


*Figure 1: Reduction of oocysts in the droppings by Pretect D*

# 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 Pretect D gives the possibility to reduce antimicrobial resistance as part of programs against coccidiosis.

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# Pathogenic Enterococcus cecorum – an emerging profit killer for broiler producers

*By **Dr. Ajay Bhoyar**, 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.

Phytogenic 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 phytogenic compounds 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 air-sacculitis. 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 phytomolecules 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. Phytomolecules, 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).

Phytomolecules 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, phytomolecules have shown promise in supporting the optimum gut health of poultry. Many phytogenic 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. Phytomolecule-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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