Mycotoxins affect intestinal health and productivity in broiler breeders

*By **Han Zhanqiang**, Poultry Technical Manager, EWN China*

Poultry meat accounts for more than one-third of global meat production. With increasing demand levels, the industry faces several challenges. Among them is the continuous supply of day-old chicks, which is affected by various issues. Mitigation strategies should be taken to ensure the supply of good quality day-old chicks to production farms.

Fast-growing broilers versus fit breeders

The poultry industry is challenged by the broiler-breeder paradox: on the one hand, fast-growing broilers are desirable for meat production. On the other hand, the parents of these broilers have the same genetic traits, but in order to be fit for reproduction, their body weight should be controlled. Thus, feed restriction programs, considering breeder nutritional requirements, are necessary to achieve breed standards for weight, uniformity, body structure, and reproductive system development, determining the success of day-old chick production.

Mycotoxins affect breeder productivity

During the rearing period, gut health problems such as coccidiosis, necrotic enteritis, and dysbiosis affect flocks. Also during the laying period, breeder flocks are also susceptible to disturbances in gut health, especially during stressful periods, leading to reduced egg production and an increase in off-spec eggs. One measure to restrain these challenges is the strict quality control of the feed. In this context, contamination with mycotoxins is an important topic. However, due to the nature of fungal contamination and limitations of sampling procedures, mycotoxins may not be detected or may be present at levels considered low and not risky.

Existing studies on mycotoxins in breeders indicate that mycotoxins can cause varying degrees of reduction in egg production and hatchability and are also associated with increased embryonic mortality. Recent studies have shown that low levels of mycotoxins interact with other stressors and may lead to reduced productivity. These losses are often mistaken for normal breeder lot variation. However, they

cause economic losses far greater than normal flock-to-flock variability.

Mycotoxins impair the functionality of the gut

Low mycotoxin levels affect gut health. Individually and in combinations, mycotoxins such as DON, FUM, and T2 can impact gut functions such as digestion, absorption, permeability, immunity, and microbial balance. This is critical in feed-restricted flocks because it decreases body weight and uniformity, and in laying animals, egg production and egg quality can be reduced. Absorption of calcium and vitamin D3, which are critical for eggshell formation, depends on gut integrity and the efficiency of digestion and absorption. These factors can be adversely affected by even low mycotoxin levels: eggshells can become thin and brittle, thereby reducing hatching eggs and increasing early embryo mortality.

Prevention is the key to success in day-old chick production, therefore:

- avoid the use of raw materials with known mycotoxin contamination.
- use feed additives prophylactically, especially with anti-mycotoxin and antioxidant properties.

Prevention is an alternative approach to assure health and productivity in -many times unknown- mycotoxin challenges.

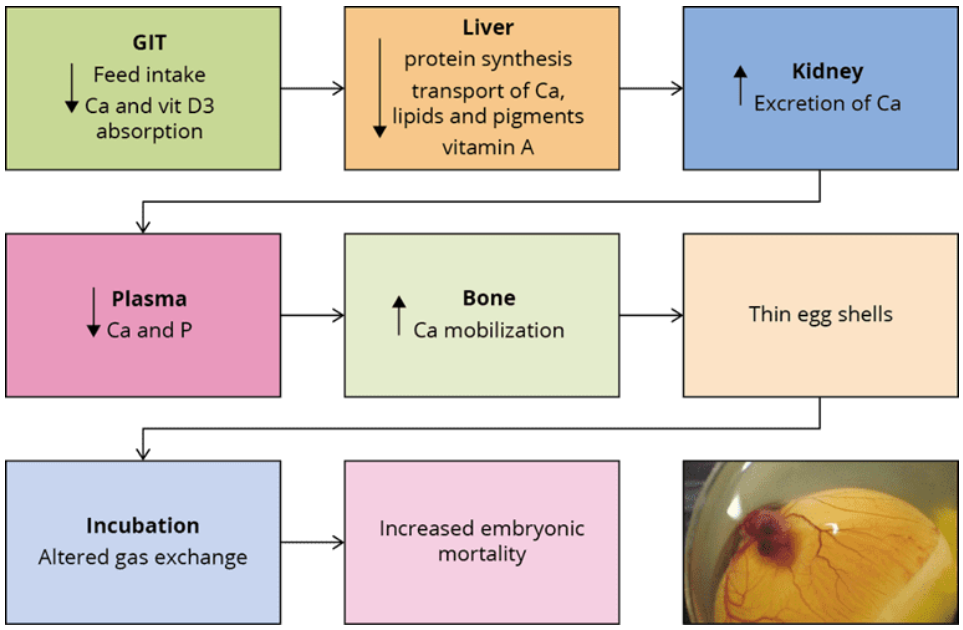


Figure 1: Effect of mycotoxins on eggshell quality and embryo death (Caballero, 2020)

University trial shows anti-mycotoxin product improving performance

A recent study by the University of Zagreb confirmed that long-term (13 weeks) exposure to feed contaminated with mycotoxins has an impact on egg production performance – a challenge that could be counteracted by using an anti-mycotoxin product.

The negative control (NC) was offered feed without mycotoxins. In contrast, the challenged control (CC), as well as a third group, received feed contaminated with 200ppb of T2, 100ppb of DON, and 2500ppb of FMB1. To the feed of the third group, an anti-mycotoxin feed additive (Mastersorb Gold, EW Nutrition) was given on top (CC+MG).

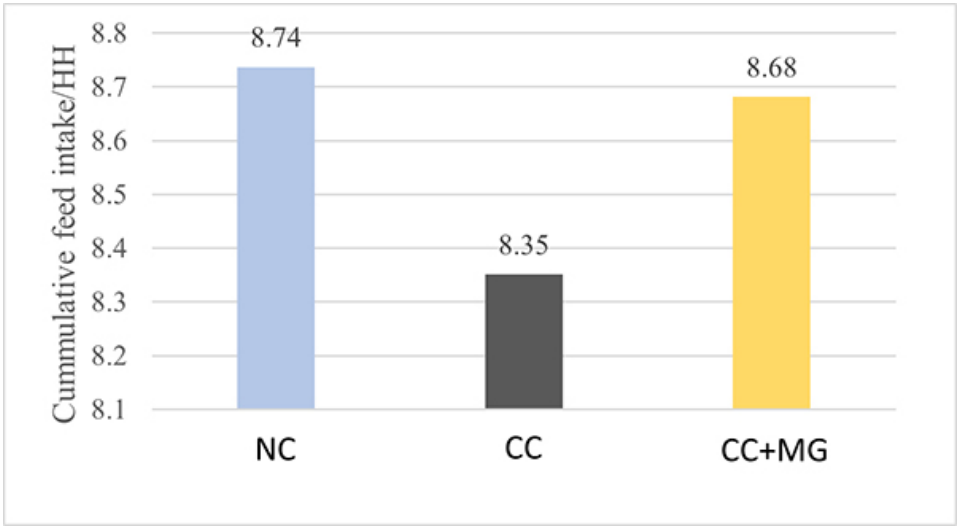


Figure 2: Influence of mycotoxins on feed intake and the effect of the anti-mycotoxin product Mastersorb Gold

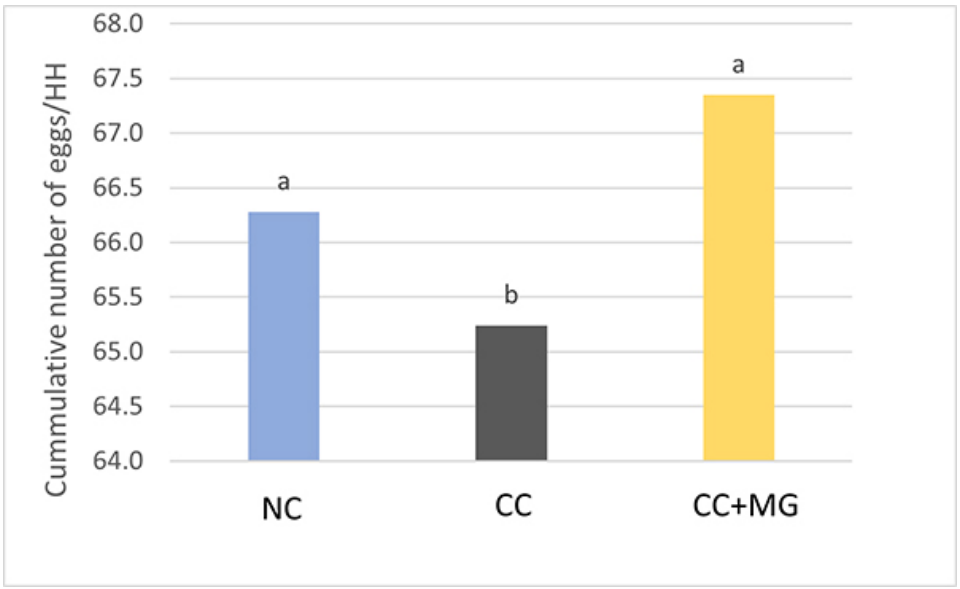


Figure 3: The effect of mycotoxins on the cumulative number of eggs and the compensating effect of Mastersorb Gold

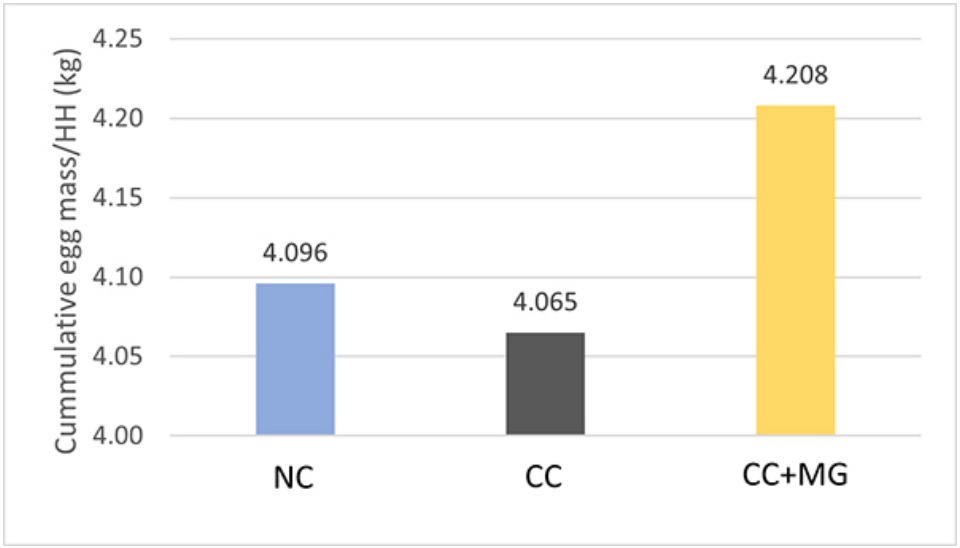


Figure 4: The impact of mycotoxins on the cumulative egg mass and the countereffect of Mastersorb Gold

As expected, the contaminated feed reduced feed intake, egg production, and egg weight (Fig. 2-4). Moreover, the liver and gut were affected which was evidenced in histopathological lesion scores of the

organs: the control group had the lowest score, followed by the group fed Mastersorb Gold. The challenged group without any anti-mycotoxin product scored the highest.

Breeders are susceptible to mycotoxins and need our support

Broiler breeders and day-old chick production can be affected by long-term exposure to mycotoxins, which often exceeds the tolerance range of average flocks. To reduce or even prevent the potential impact of mycotoxins, a comprehensive management strategy is crucial. This includes responsible raw material procurement, storage, and feed processing leading to high feed quality, and the consideration of breeders' nutrient demands. The inclusion of highly effective products to manage mycotoxin risk is an additional tool to maintain breeder performance.

Feed hygiene protects animals and humans

*By **Vaibhav Gawande**, Assistant Manager Technical Services, **Dr. Inge Heinzl**, Editor, and **Marisabel Caballero**, Global Technical Manager Poultry, EW Nutrition*

The utility value of feed consists of the nutritional value and the quality. The first covers all characteristics concerning the essential nutrients and is important for feed formulation and the adequate supply of the animals.

Feed quality comprises all characteristics of a feed influenced by treatment, storage, conservation, hygiene, and its content of specific substances. For many factors, guidance and threshold values are available which should be met to guarantee animal health and welfare, as well as to protect public health, since some undesirable substances can be transferred to animal products such as meat, eggs, and milk.

In this article, we will focus on feed hygiene. We will talk about the consequences of low feed quality, how to understand it, its causes, and possible solutions.

What are the effects of deficient feed hygiene?

The consequences of deficient feed hygiene can be divided into two parts, impurities and spoilage.

Impurities comprise:

- the presence of soil, sand, or dust
- contamination with or residues of heavy metals, PCB, dioxins, pesticides, fertilizers, disinfectants, toxic plants, or banned feed ingredients

In the case of spoilage, we see:

- degradation of organic components by the action of molds and bacteria
- growth of pathogens such as E. coli, salmonella, etc.
- accumulation of toxins such as mycotoxins or bacterial toxins (Hoffmann, 2021)

Bad feed hygiene can also negatively impact the feed's nutritional value by leading to a loss of energy as well as decreasing the bioavailability of vitamins A, D3, E, K, and B1.

But, how can all signs of deficient feed hygiene be recognized? Soil, sand, and probably dust can be seen in well-taken samples and impurities can be analyzed. But is it possible to spot spoilage? In this case, agglutinated particles, rancid odor, moisture, and discoloration are indicators. Sometimes, also the temperature of the feed or ingredient increases. However, spoilage is not always obvious and an analysis of the feed can give more information about the spoilage-related organisms present. It also helps to decide if the feed is safe for the animals or not. In the case of obvious alterations, the feed should not be consumed by any animal.

Different organisms decrease feed quality and impact health

Several organisms can be responsible for a decrease in feed quality. Besides the visible pests such as rats, mice, or beetles, which can easily be noticed and combatted, there are organisms whose mastering is much more difficult. In the following part, the different harmful organisms and substances are described and solutions are presented.

Enteropathogens can cause diarrhea and production losses

In poultry, different bacteria responsible for high production losses can be transferred via the feed. The most relevant of them are Clostridium perfringens, Escherichia coli, and some strains of Salmonella.

Clostridium perfringens, the cause of necrotic enteritis

Clostridium perfringens is a Gram-positive, anaerobic bacterium that is extremely resistant to environmental influences and can survive in soil, feed, and litter for several years and even reproduce. Clostridium perfringens causes necrotic enteritis mainly in 2-16 weeks old chickens and turkeys, being more critical in 3-6 weeks old chicks.

There is a clinical and a subclinical form of necrotic enteritis. The clinical form can be detected very well due to clear symptoms and mortality rates up to 50%. The subclinical form, while harder to detect, also raises production costs due to a significant decrease in performance. The best prophylaxis against clostridia is the maintenance of gut health, including feed hygiene.

Clostridia can be found in animal by-products, as can be seen in table 1.

Sr. No.	Sample details	Clostridium perfringens contamination		Total number of samples	Positivity %
		Positive	Negative		
1	Meat and bone meal	39	52	91	42.86
2	Soya meal	0	3	3	0
3	Rape seed meal	0	1	1	0
4	Fish meal	21	17	38	55.26
5	Layer Feed	21	71	93	22.58
6	Dry fish	5	8	13	38.46
7	De-oiled rice bran	0	2	2	0
8	Maize	0	2	2	0
9	Bone meal	13	16	29	44.83

Table 1: Isolation of Clostridium perfringens from various poultry feed ingredients in Tamil Nadu, India (Udhayavel et al., 2017)

Salmonella is harmful to animals and humans

Salmonella is a gram-negative enterobacterium and can occur in feed. There are only two species – S. enterica and S. bongori (Lin-Hui and Cheng-Hsun, 2007), but almost 2700 serotypes. The most known poultry-specific Salmonella serotypes are S. pullorum affecting chicks and S. gallinarum affecting adult birds. The other two well-known serotypes, S. enteritidis and S. typhimurium are the most economically important ones because they can also infect humans.

Salmonella enteritidis, in particular, can be transferred via table eggs to humans. The egg content can be infected vertically as a result of a colonization of the reproductive tract of the hen (De Reu, 2015). The other possibility is a horizontal infection, as some can penetrate through the eggshell from a contaminated environment or poor egg handling.

Salmonella can also be transferred through meat. However, as there are more production steps where contamination can happen (breeder and broiler farm, slaughterhouse, processing plants, food storage…), traceability is more complicated. As feed can be vector, feed hygiene is crucial.

Moreover, different studies have found that the same Salmonella types found in feed are also detected – weeks later – in poultry farms and even further in the food chain, as reviewed by Ricke and collaborators (2019). Other researches even imply that Salmonella contamination of carcasses and eggs could be significantly reduced by minimizing the incidence of Salmonella in the feed (Shirota et al., 2000).

E. coli – some are pathogenic

E. coli is a gram-negative, not acid-resistant bacterium and most strains are inhabitants of the gut flora of birds, warm-blooded animals, and humans. Only some strains cause disease. To be infectious, the bacteria must have fimbriae to attach to the gut wall or the host must have an immune deficiency, perhaps due to

stress. E. coli can be transmitted via contaminated feed or water as well as by fecal-contaminated dust.

Escherichia coli infections can be found in poultry of all ages and categories and nearly everywhere in the bird. E. coli affects the navel of chicks, the reproductive organs of hens, several parts of the gut, the respiratory tract, the bones and joints, and the skin and are part of the standard control.

The feed microbiome can contribute to a balanced gut microbial community. The origins of pathogenic E. coli in a flock can also be traced to feed contamination (Stanley & Bajagai, 2022). Especially in pre-starter/starter feeds, E. coli contamination can be critical as the day-old chick's gut is starting to be colonized. Especially in this phase, maintaining a low microbial count in feed is crucial.

Molds cause feed spoilage and reduce nutritional value

Molds contaminate grains, both in the field and during storage, and can also grow in stored feed and even in feed stored or accumulated in storage facilities in animal production farms.

The contamination of feed by molds and their rapid growth can cause heating of the feed. As molds also need nutrients, their growth results in a reduction of energy and the availability of vitamins A, D3, E, K, and B1, thus decreasing the feed's nutritional value. This heating occurs in most feeds with a moisture content higher than 15 /16%. Additionally, mold-contaminated feed tends to be dusty and has a bad taste impacting palatability and, as a consequence, feed intake and performance.

Molds produce spores that can, when inhaled, cause chronic respiratory disease or even death if the animals are exposed to contaminated feed for a longer time. Another consequence of mold contamination is the production of mycotoxins by several mold species. These mycotoxins can affect the animal in several ways, from decreasing performance to severe disease (Esmail, 2021; Government of Manitoba, 2023).

With effective feed hygiene management, we want to stop and prevent mold growth, as well as all its negative consequences.

Prevention is better than treatment

It is clear that when the feed is spoiled, it must be removed, and animal health supporting measures should take place. However, it is better to prevent the consequences of low feed hygiene on animals. Proper harvest and adequate storage of the feed are basic measures to stop mold growth. Additionally, different tools are available to protect the animals from feed bacterial load and other risk factors.

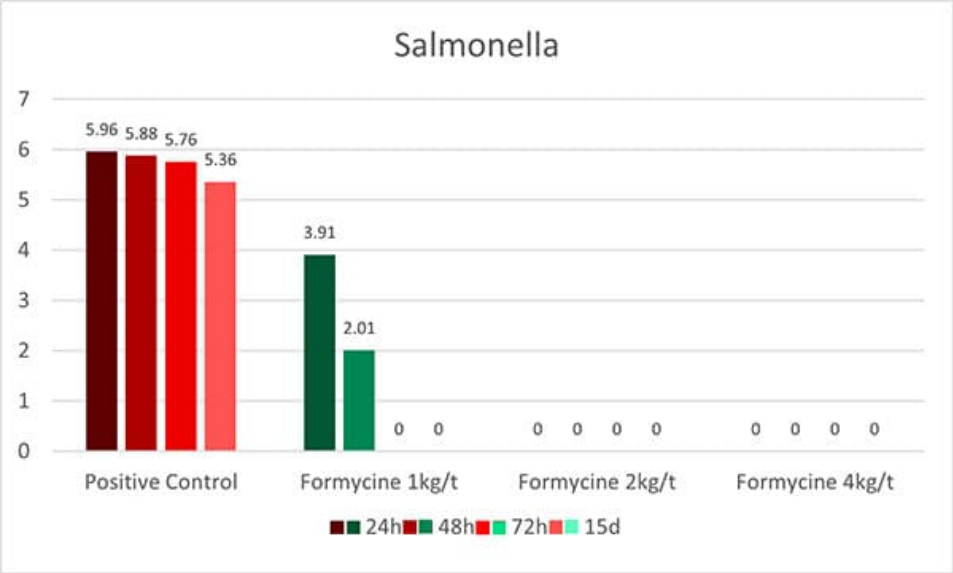
Solutions are available to support feed hygiene

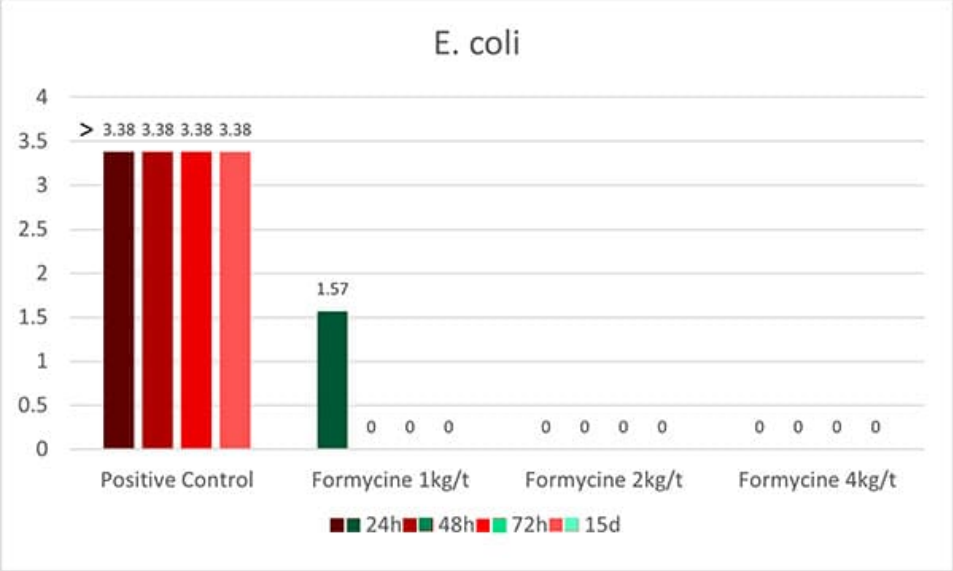
There are several solutions to fight the organisms which decrease feed quality. Some directly act against the harmful substances / pathogens, and others act indirectly, meaning that they change the environment to a non-comfortable one for the organism.

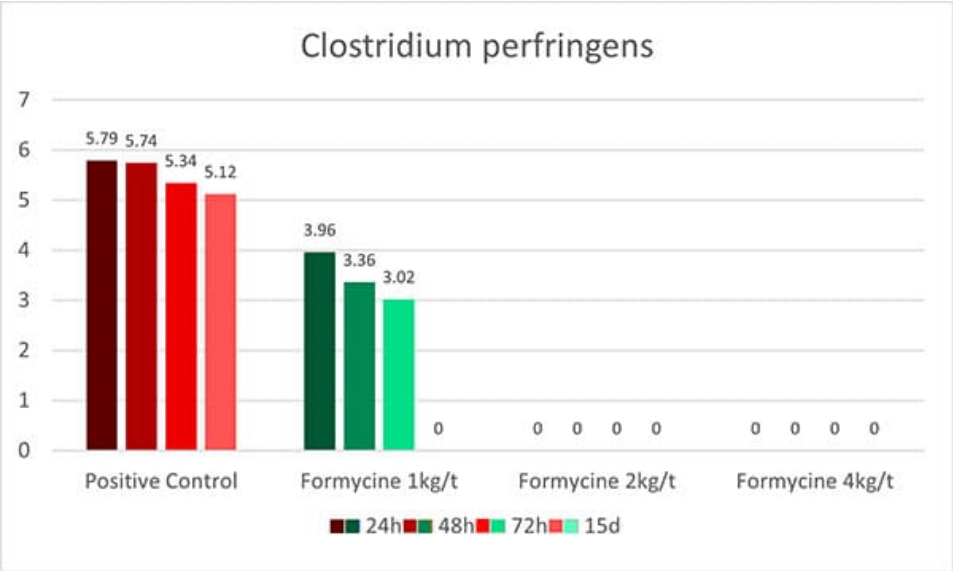
Formaldehyde and propionic acid – an unbeatable team against bacteria

A combination of formaldehyde and propionic acid is perfect to sanitize feed. Formaldehyde results in bacterial DNA and protein damage, and propionic acid is active against bacteria and molds. Together, they improve the microbiological quality of the feed and reduce the risk of secondary diseases such as necrotic enteritis or dysbiosis on the farm. In addition to the pure hygienic aspect, organic acids support digestion.

An in-vitro trial was conducted to evaluate the effect of such a combination (Formycine Gold Px) against common poultry pathogens. Poultry feed was spiked with three different bacteria, achieving very high initial contamination of 1,000,000 CFU/g per pathogen. One batch of the contaminated feed served as a control (no additive). To the other contaminated batches, 1, 2, or 4 kg of Formycine per ton of feed were added. The results (means of triplicates) are shown in figures 1 a-c.







Figures 1 a-c: Reduction of bacterial count due to the addition of Formycine

Formycine Gold Px significantly reduced the bacterial counts in all three cases. A clear dose-response-effect can be seen and by using 2 kg of Formycine / t of feed, pathogens could not be detected anymore in the feed.

A further trial showed the positive effects of feeding Formycine Gold Px treated feed to the animals. Also here, the feed for both groups was contaminated with 1,000,000 CFU of Clostridium/g. The feed of the control group was not treated and to the treatment group, 2 kg of Formycine per t was added.

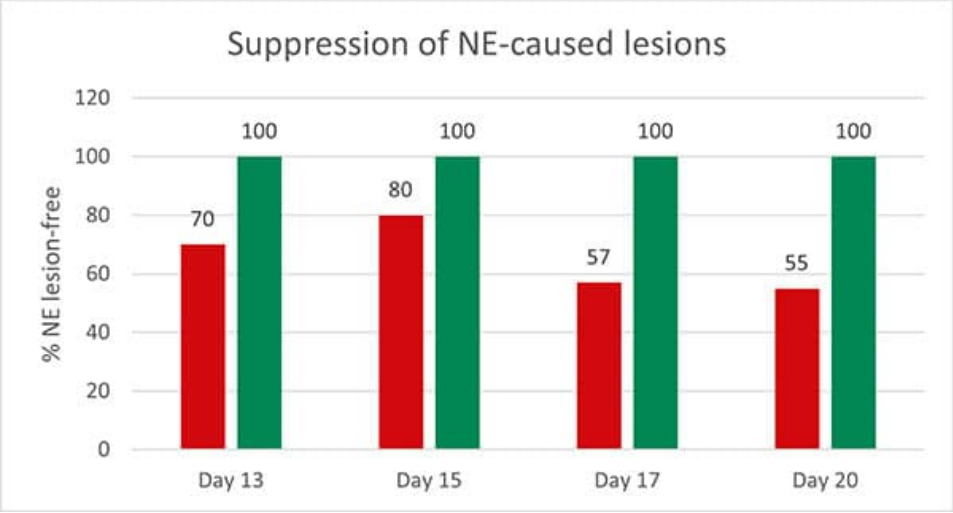


Figure 2: Preventive effect of Formycine Gold Px concerning necrotic enteritis gut lesions

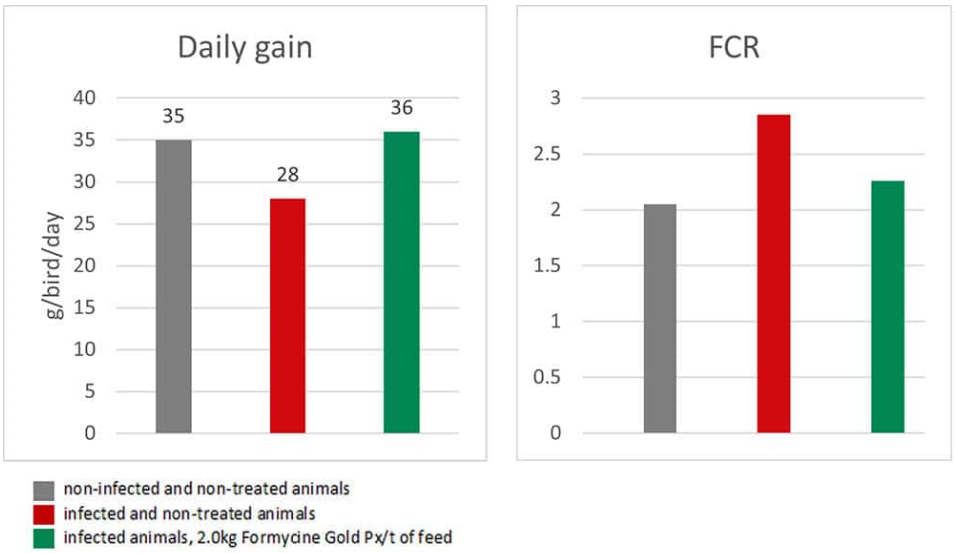


Figure 3a and 3b: Performance-maintaining effect of Formycine Gold Px

The trial showed that Formycine Gold Px reduced the ingestion of the pathogen, and thus could prevent the lesions caused by necrotic enteritis (Fig. 2). The consequence of this improved gut health is a better feed conversion and higher average daily gain (Fig.3a and 3b).

Products containing formaldehyde may represent a risk for humans, however, the adequate protection equipment helps to reduce/avoid exposure.

A combination of free acids and acid salts provides optimal hygienic effects

Additionally, another blend of organic acids (Acidomix AFG) shows the best effects against representatives of relevant feed-borne pathogens in poultry. In a test, 50 µl solution containing different microorganisms (reference strains of S. enterica, E. coli, C. perfringens, C. albicans, and A. niger; concentration 10^5 CFU/ml, respectively) were pipetted into microdilution plates together with 50 µl of increasing concentrations of a mixture of organic acids (Acidomix) After incubation, the MIC and MBC of each pathogen were calculated.

The test results show (figure 4, Minimal Bactericidal Concentration) that 0.5% of Acidomix AFG in the medium (≙ 5kg/t of feed) is sufficient to kill S. enterica, C. albicans, and A. niger and even only 2.5kg/t in the case of E. coli. If the pathogens should only be prevented to proliferate, even a lower amount of product is requested (figure 5, Minimal Inhibitory Concentration – MIC)

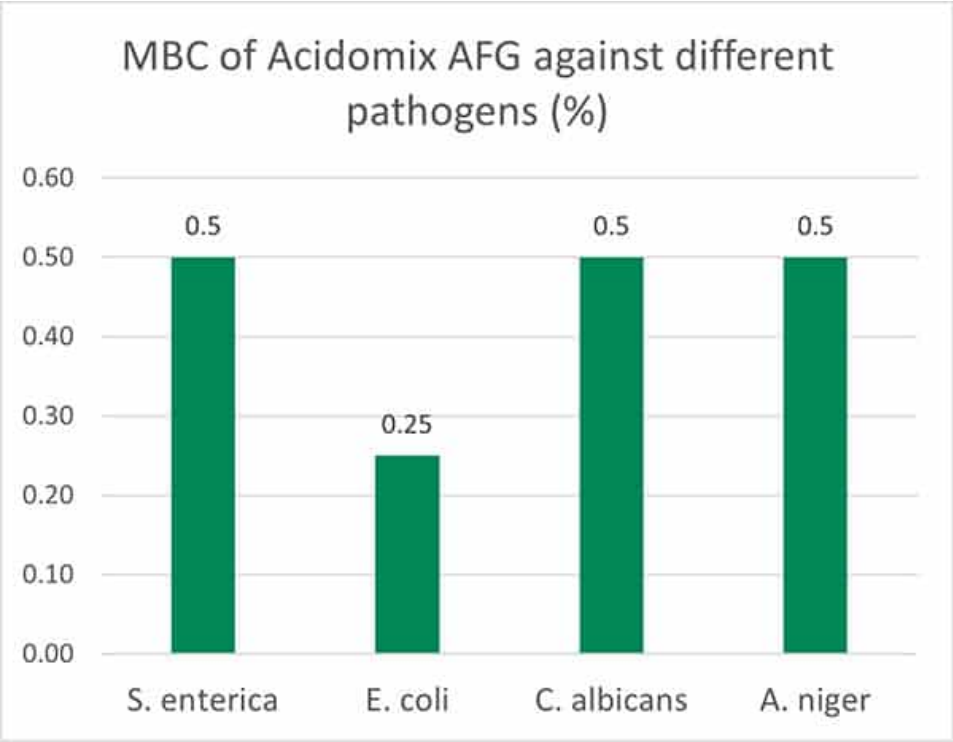


Figure 4: MBC of Acidomix AFG against different pathogens (%)

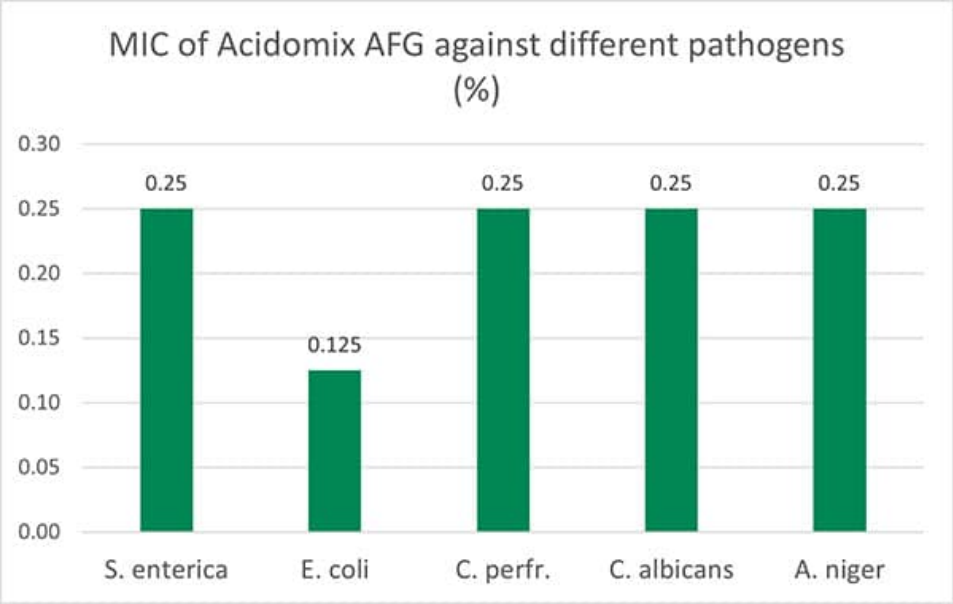


Figure 5: MIC of Acidomix AFG against different pathogens (%)

In addition to the direct antimicrobial effect, this product decreases the pH of the feed and reduces its buffering capacity. The combination of free acids and acid salts provides prompt and long-lasting effects.

Feed hygiene: a critical path to animal performance

Feed accounts for 65-70% of broiler and 75-80% of layer production costs. Therefore, it is essential to use the available feed to the utmost. The quality of the feed is one decisive factor for the health and performance of the animals. Proper harvesting and storage are in the hands of the farmers and the feed millers. The industry offers products to control the pathogens causing diseases and the molds producing toxins and, therefore, helps farmers save feed AND protect the health and performance of their animals.

References:

Dinev, Ivan. *Diseases of Poultry: A Colour Atlas*. Stara Zagora: Ceva Sante Animal, 2007.

Esmail, Salah Hamed. “Moulds and Their Effect on Animal Health and Performance.” All About Feed, June 17, 2021. https://www.allaboutfeed.net/all-about/mycotoxins/moulds-and-their-effect-on-animal-health-and-performance/.

Government of Manitoba. “Spoiled Feeds, Molds, Mycotoxins and Animal Health.” Province of Manitoba – Agriculture. Accessed March 16, 2023. https://www.gov.mb.ca/agriculture/livestock/production/beef/spoiled-feeds-molds-mycotoxins-and-animal-health.html.

Hoffmann, M. “Tierwohl Und Fütterung.” LKV Sachsen: Tierwohl und Fütterung. Sächsischer Landeskontrollverband e.V., January 25, 2021. https://www.lkvsachsen.de/fuetterungsberater/blogbeitrag/artikel/tierwohl-und-fuetterung/.

Ricke, Steven C., Kurt Richardson, and Dana K. Dittoe. “Formaldehydes in Feed and Their Potential Interaction with the Poultry Gastrointestinal Tract Microbial Community–A Review.” *Frontiers in Veterinary Science* 6 (2019). https://doi.org/10.3389/fvets.2019.00188.

Shirota, Kazutoshi, Hiromitsu Katoh, Toshihiro Ito, and Koichi Otsuki. “Salmonella Contamination in Commercial Layer Feed in Japan.” *Journal of Veterinary Medical Science* 62, no. 7 (2000): 789–91. https://doi.org/10.1292/jvms.62.789.

Stanley, Dragana, and Yadav Sharma Bajagai. “Feed Safety and the Development of Poultry Intestinal Microbiota.” *Animals* 12, no. 20 (2022): 2890. https://doi.org/10.3390/ani12202890.

Su, Lin-Hui, and Cheng-Hsun Chiu. “Salmonella: Clinical Importance and Evolution of Nomenclature.” *Chang Gung Med J* 30, no. 3 (2007): 210–19.

Udhayavel, Shanmugasundaram, Gopalakrishnamurthy Thippichettypalayam Ramasamy, Vasudevan Gowthaman, Shanmugasamy Malmarugan, and Kandasamy Senthilvel. “Occurrence of Clostridium Perfringens Contamination in Poultry Feed Ingredients: Isolation, Identification and Its Antibiotic Sensitivity Pattern.” *Animal Nutrition* 3, no. 3 (2017): 309–12. https://doi.org/10.1016/j.aninu.2017.05.006.

Layer production losses: causes, types, solutions

*By **Dr. Sandeep Dwivedi, MVSc.**, Astt. Manager Technical Services, EW Nutrition India*

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

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

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

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

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

Factors affecting layer gut health

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

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

Feed and water are essential

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

Some common influences:

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

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

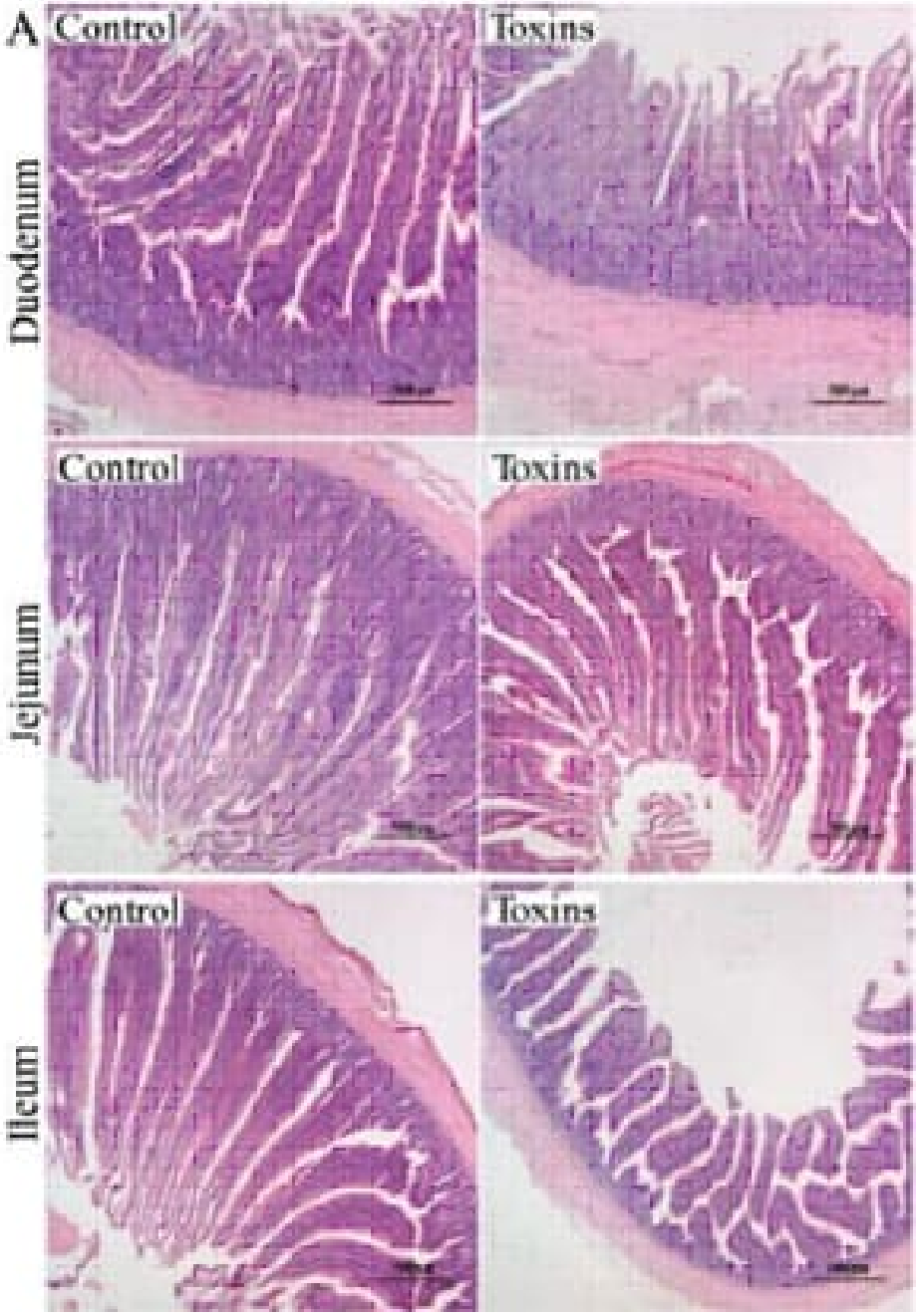


Fig. 1: Effects of dietary mycotoxins on histopathology of the duodenum, jejunum, and ileum Adapted from Zhao et al., 2021 (3)

Layer gut health: An increasing concern

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

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

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

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

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

Gut health-associated production losses in laying hens

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

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

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

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

Eggshell quality issue

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

Bone fractures

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

Increase in soiled eggs percentage

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

Internal egg quality changes

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

Low egg laying percentage and small egg size

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

Strategies for gut health maintenance

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

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

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

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

General water management guidelines

1. Ensure adequate cleaning between flocks:
    - Removing biofilm (e.g., 25-50 ppm Hydrogen peroxide in the water line for 24-72 hours, then flush)
    - Removing scale (target a pH of 5 with weak acid, e.g. citric acid – leave in line for 24 hours, then flush)

2. Prior to bird arrival

    - Use bleach solution in standing water
    - Flush just before birds arrive

3. Throughout the life of the flock

    - Sanitize (e.g., Chlorine [2-4 ppm] or Chlorine dioxide [0.8 ppm])
    - Acidify water (pH 5.5-7)
    - Perform waterline biofilm removal at regular intervals throughout the life of the flock (biofilms can form in 6 weeks)
    - Routinely check ORP (oxygen reduction potential) at the drinker furthest from the water tank to check the efficacy of sanitation; it should be >650 mv)

Gut health additives

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

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

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

What are the key periods?

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

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

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

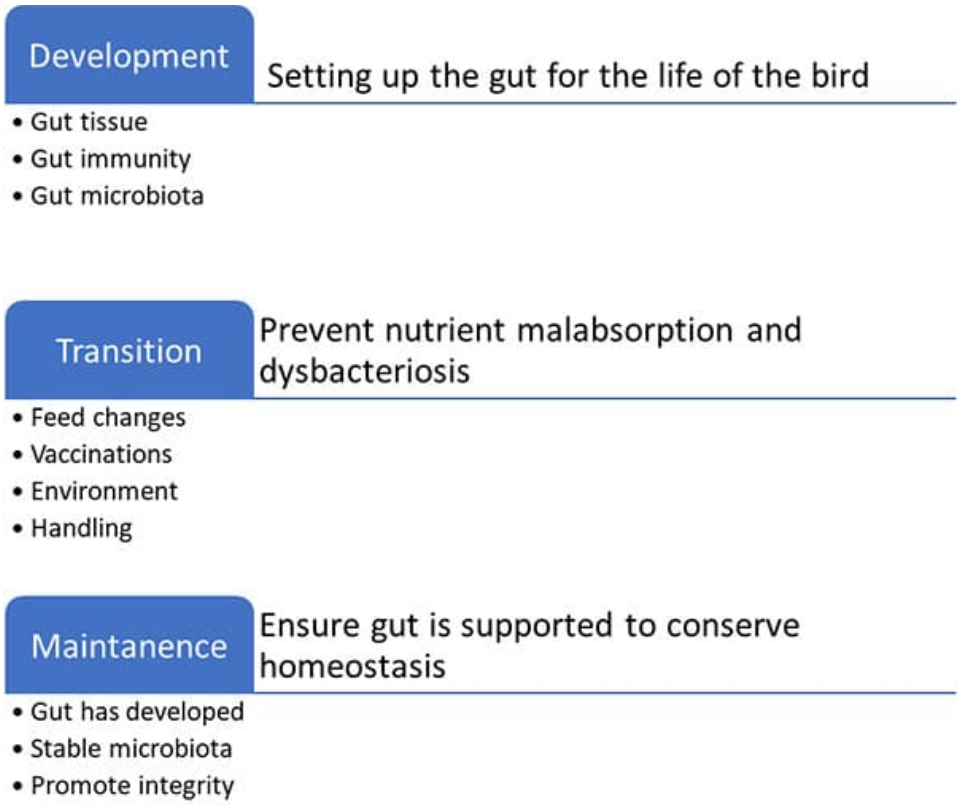


Fig2: Gut need assessment and management strategy

Phytomolecules mitigate gut health challenges

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

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

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

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

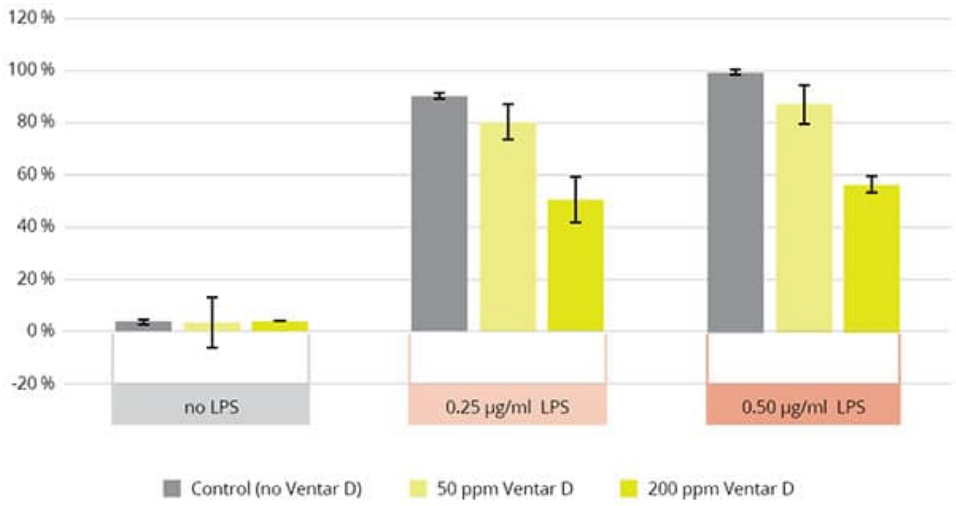


Figure 3. NFkB activity with phytomolecule-based product Ventar D (EW Nutrition)

Conclusion

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

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

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

References:

1. https://www.un.org/en/desa/world-population-projected-reach-98-billion-2050-and-112-billion-2100#:~:text=COVID%2D19,World%20population%20projected%20to%20reach%209.8%20billion%20in%202050%2C%20and,Nations%20report%20being%20launched%20today.
2. Zaefarian, F., Abdollahi, M. R., & Ravindran, V. (2016). Particle size and feed form in broiler diets: impact on gastrointestinal tract development and gut health. *World's Poultry Science Journal*, *72*(2), 277-290.

3. Zhao L, Feng Y, Wei J-T, Zhu M-X, Zhang L, Zhang J-C, Karrow NA, Han Y-M, Wu Y-Y, Guo Y-M, Sun L-H. Mitigation Effects of Bentonite and Yeast Cell Wall Binders on AFB_1, DON, and OTA Induced Changes in Laying Hen Performance, Egg Quality, and Health. *Toxins*. 2021; 13(2):156. https://doi.org/10.3390/toxins13020156
4. He, F., Peng, J., Deng, X. L., Yang, L. F., Camara, A. D., Omran, A., ... & Yin, F. (2012). Mechanisms of tumor necrosis factor-alpha-induced leaks in intestine epithelial barrier. *Cytokine*, *59*(2), 264-272.
5. Dragoș, D., Petran, M., Gradinaru, T. C., & Gilca, M. (2022). Phytochemicals and Inflammation: Is Bitter Better?. *Plants*, *11*(21), 2991.

EW Nutrition showcases customer-focused solutions for the animal nutrition industry at VIV Asia 2023

Singapore – March 1, 2023 – EW Nutrition will participate in VIV Asia 2023 to showcase science-backed solutions that meet the challenging needs of the animal nutrition industry. Held in Bangkok, Thailand, from March 8 to 10, 2023, VIV Asia is one of the biggest and most complete feed to food events in Asia, dedicated to the world of livestock production and animal husbandry.

“We are constantly innovating to provide best-in-class concepts and solutions for the industry. Our participation in VIV Asia 2023 will be a good opportunity to connect and discuss with our partners on how to collaborate to provide customised solutions in line with their needs.” said **Ramakanta Nayak**, regional director for EW Nutrition South East Asia/Pacific.

Located at Booth 3550, guests are invited to explore EW Nutrition’s new solutions and initiatives at this year’s VIV Asia, such as:

- **Ventar D**
  Ventar D is a high-ROI, innovative proprietary blend of phytomolecules with efficient delivery, formulated to consistently support gut health and improve performance.
- **Pretect D**
  Pretect D acts as a natural solution to support the efficiency of coccidiosis control. Pretect D, a unique proprietary blend of phytomolecules, offers natural support during Eimeria-related challenges, making it an effective addition to programs focused on coccidiosis control.

- **Spearhead**
  EW Nutrition strives to contribute to sustainability in the animal protein production chain through the new initiative “Spearhead”, focusing on highly improved feed conversion, reduced energy use, reduced contaminants, and reduced emissions from farms.

Partnering with industry experts and key opinion leaders, EW Nutrition is also inviting VIV guests to attend a series of topical presentations at the booth. Under the title “Showtime”, these presentations aim to provide actionable insights and encourage discussion about the trends and challenges of the animal nutrition industry. “Showtime” covers a variety of topics, including:

- Why is it important to measure outside temperature properly, 8 March, 11am
- Coccidiosis Vaccination: Don’t take it for granted!, 8 March, 3pm
- Antibiotics reduction – the way forward for safe & sustainable food production, 8 March, 4pm
- Feed cost optimization, 9 March, 11am
- Better gut health, better egg shells, 9 March, 3pm
- Water – the central nutrient for growth, 10 March, 11am

About EW Nutrition

EW Nutrition offers animal nutrition solutions to the feed industry. The company’s focus is on gut health, supported by other product lines. EW Nutrition researches, develops, produces, sells, and services most of the products it commercializes. In 50 countries, key accounts are served directly by EW Nutrition’s own personnel.

For more information, please visit https://ew-nutrition.com.

Contact:

Zack Mai
Marketing Manager, EW Nutrition South East Asia/Pacific
Phone no.: +65 6735 0038
Email: zack.mai@ew-nutrition.com

Managing gut health – a key challenge in ABF broiler production

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

Gut health is a critical challenge in antibiotics-free (ABF) production as it plays a vital role in the overall health and well-being of animals. Antibiotics have long been used as a means of preventing and treating diseases in animals, but their overuse has led to the development of antibiotic-resistant bacteria. As a result, many farmers and producers are shifting towards antibiotics-free production methods. This shift presents a significant challenge as maintaining gut health without antibiotics can be difficult. It is, however, not impossible.

One of the main challenges in antibiotics-free production is the prevention of bacterial infections in the gut. The gut microbiome plays a crucial role in the immune system and overall health of animals. When the balance of microbes in the gut is disrupted (dysbiosis), it can lead to poor nutrient absorption which subsequently results in reduced live bird performance including feed efficiency and weight gain in broiler chicken. In the absence of antibiotics, farmers and producers must rely on other methods to maintain a healthy gut microbiome.

Antibiotic reduction – a major global trend

The trend in recent years has been for poultry producers to reduce their use of antibiotics to promote public health and improve the sustainability of their operations. This has been driven by concerns about the development of antibiotic-resistant bacteria and the potential impact on human health, as well as by consumer demand for meat produced without antibiotics. Many countries now have regulations in place that limit the use of antibiotics in food and animal production.

Challenges to antibiotics-free poultry (ABF) production

1. **Disease control**. Antibiotic-free poultry production requires farmers to rely on alternative methods for controlling and preventing diseases, such as stepped-up biosecurity practices. This can be more labor-intensive and costly.
2. **Higher mortality rates.** Without antibiotics, poultry farmers may experience higher mortality rates due to disease outbreaks and other health issues. This can lead to financial losses for the farmer and a reduced supply of poultry products for consumers.
3. **Feeding challenges.** Antibiotic growth promotors (AGPs) are often used in feed to promote growth and prevent intestinal disease in poultry. Without AGPs, poultry producers can find alternative ways to ensure expected production performance.
4. **Increased cost.** Antibiotic-free poultry production can be more expensive than conventional production methods, as farmers must invest in additional housing, equipment, labor, etc.

Phasing out AGPs will likely lead to changes in the microbial profile of the intestinal tract. It is hoped that strategies such as infectious disease prevention programs and using non-antibiotic alternatives minimize possible negative consequences of antibiotic removal on poultry flocks (Yegani and Korver, 2008).

Gut health is key to overall health

A healthy gastrointestinal system is important for poultry to achieve its maximum production potential. Gut health in poultry refers to the overall well-being and functioning of the gastrointestinal tract in birds. This includes the balance of beneficial bacteria, the integrity of the gut lining, and the ability to digest and absorb nutrients. Gut health is important for maintaining the overall health and well-being of the birds. A healthy gut helps to improve feed efficiency, nutrient absorption, and the overall immunity of the birds.

The gut is host to more than 640 different species of bacteria and 20+ different hormones. It digests and absorbs the vast majority of nutrients and makes up for nearly a quarter of body energy expenditure. It is also the largest immune organ in the body (Kraehenbuhl and Neutra, 1992). Consequently, 'gut health' is highly complex and encompasses the macro and micro-structural integrity of the gut, the balance of the microflora, and the status of the immune system (Chot, 2009).

Poultry immunity is mediated by the gut

The gut is a critical component of the immune system, as it is the first line of defense against pathogens that enter the body through the digestive system. Chickens have a specialized immune system in the gut, known as gut-associated lymphoid tissue (GALT), which helps to identify and respond to potential pathogens. The GALT includes Peyer's Patches, which are clusters of immune cells located in the gut wall, as well as the gut-associated lymphocytes (GALs) that are found throughout the gut. These immune cells are responsible for recognizing and responding to pathogens that enter the gut.

The gut-mediated immune response in chickens involves several different mechanisms, including the activation of immune cells, the production of antibodies, and the release of inflammatory mediators. The GALT and GALs play a crucial role in this response by identifying and responding to pathogens, as well as activating other immune cells to help fight off the infection.

The gut microbiome also plays a critical role in gut-mediated immunity in chickens. The gut microbiome is made up of a highly varied community of microorganisms, and these microorganisms can have a significant impact on the immune response. For example, certain beneficial bacteria can help to stimulate the immune response and protect the gut from pathogens.

Overall, the gut microbiome, GALT, and GALs all work together to create an environment that is hostile to pathogens while supporting the growth and health of beneficial microorganisms.

Dysbiosis/Dysbacteriosis impacts performance

Dysbiosis is an imbalance in the gut microbiota because of an intestinal disruption. Dysbacteriosis can lead to wet litter and caking issues. Prolonged contact with the caked litter can lead to pododermatitis (feet ulceration) and hock-burn, resulting in welfare issues as well as degradation of the carcass (Bailey, 2010). Apart from these issues, the major economic impact comes from reduced growth rates, FCR, and increased veterinary treatment costs. Coccidiosis infection and other enteric diseases can be aggravated when dysbiosis is prevalent. Generally, animals with dysbiosis have high concentrations of *Clostridium* that generate more toxins, leading to necrotic enteritis.

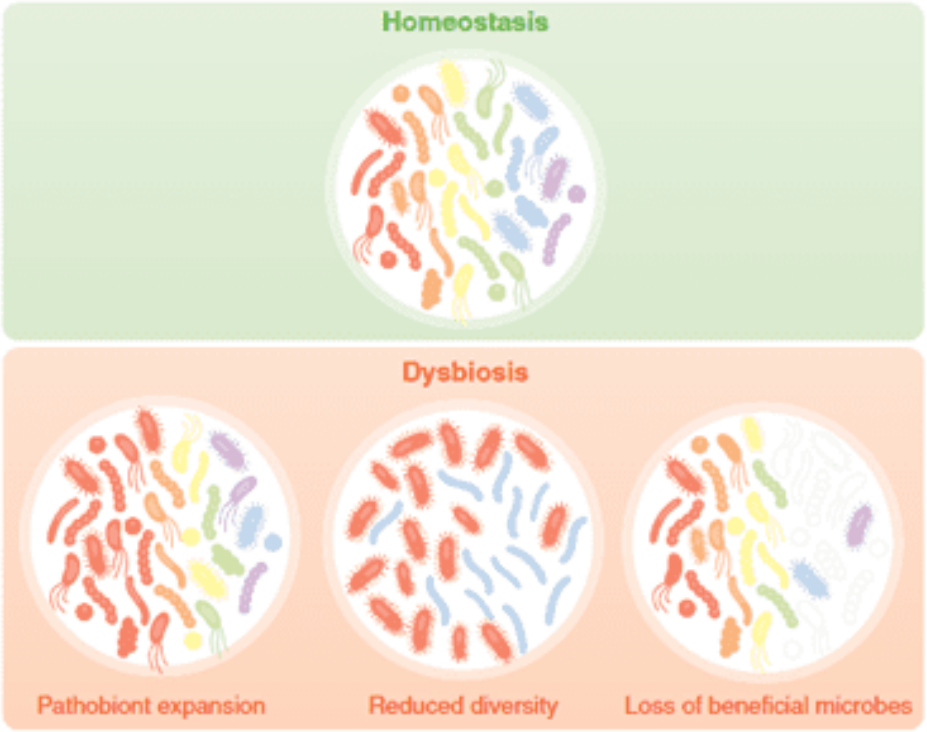


Fig.1: Dysbiosis – a result of challenging animal's microbiome. Source: Charisse Petersen and June L. Round. 2014

It is believed that both non-infectious and infectious factors can play a role in dysbacteriosis (DeGussem, 2007). Any changes in feed and feed raw materials, as well as the physical quality of feed, influence the balance of the gut microbiota. There are some risk periods during poultry production when the bird will be challenged, for example during feed change, vaccination, handling, transportation, etc. During these periods, the gut microbiota can fluctuate and, in some cases, if management is sub-optimal, dysbacteriosis can occur.

Infectious agents that potentially play a role in dysbacteriosis include mycotoxins, *Eimeria* spp., *Clostridium perfringens*, and other bacteria producing toxic metabolites.

Factors affecting gut health

The factors affecting broiler gut health can be summarized as follows:

1. **Feed and water quality**: The form, type, and quality of feed provided to broilers can significantly impact their gut health. Consistent availability of cool and hygienic drinking water is crucial for optimum production performance.
2. **Stress**: Stressful conditions, such as high environmental temperatures or poor ventilation, can lead to an imbalance in the gut microbiome and an increased risk of disease.
3. **Microbial exposure**: Exposure to pathogens or other harmful bacteria can disrupt the gut microbiome and lead to gut health issues.
4. **Immune system**: A robust immune system is important for maintaining gut health, as it helps to prevent the overgrowth of harmful bacteria and promote the growth of beneficial bacteria.
5. **Sanitation**: Keeping the broiler environment clean and free of pathogens is crucial for maintaining gut health, as bacteria and other pathogens can easily spread and disrupt the gut microbiome.
6. **Management practices**: Proper management practices, such as proper feeding and watering, and litter management can help to maintain gut health and prevent gut-related issues.

Fig. 2. Key factors affecting broilers' gut health

Key approaches for managing gut health without antibiotics

Two key approaches for managing gut health in poultry without the use of antibiotics are outstandingly successful.

Proper nutrition and management practices

Ensuring the birds have access to clean water, high-quality feed, and a stress-free environment is crucial for ABF poultry production. A balanced diet in terms of protein, energy, and essential vitamins and minerals is essential for maintaining gut health.

The environment in which birds have kept plays a major role in maintaining gut health. Proper sanitation and ventilation, as well as the right temperature and humidity, are crucial to prevent the spread of disease and infection. There is no alternative to the strict implementation of stringent biosecurity measures to prevent the spread of disease.

Early detection and treatment of diseases can help to prevent them from becoming more serious problems affecting the profitability of ABF production. It is important to keep a close eye on birds for signs of disease, such as diarrhea, reduced water, and feed consumption.

Gut health-promoting feed additives

Another approach to maintaining gut health in antibiotics-free poultry production is using gut health-supporting feed additives. A variety of gut health-supporting feed additives including phytochemicals/essential oils, organic acids, probiotics, prebiotics, exogenous enzymes, etc. in combination or alone are used in animal production. Particularly, phytogenic feed additives (PFAs) have gained interest as cost-effective feed additives with already well-established effects on improving broiler chickens' intestinal health.

Plant secondary metabolites and essential oils (generically called phytogenics, phytochemicals, or phytomolecules) are biologically active compounds that have recently garnered interest as feed additives in poultry production, due to their capacity to improve feed efficiency by enhancing the production of digestive secretions and nutrient absorption. This helps reduce the pathogenic load in the gut, exert antioxidant properties and decrease the microbial burden on the animal's immune status (Abdelli et al.

2021).

Plant extracts – Essential oils (EOs) /Phytomolecules

Phytochemicals are naturally occurring compounds found in plants. Many phytomolecules have been found to have antimicrobial properties, meaning they can inhibit the growth or kill microorganisms such as bacteria, viruses, and fungi. Examples of phytomolecules with antimicrobial properties include compounds found in garlic, thyme, and tea tree oil. Essential oils (EOs) are raw plant extracts (flowers, leaves, roots, fruit, etc.) whereas phytomolecules are active ingredients of essential oils or other plant materials. A phytomolecule is clearly defined as one active compound. Essential oils (EOs) are important aromatic components of herbs and spices and are used as natural alternatives for replacing antibiotic growth promoters (AGPs) in poultry feed. The beneficial effects of EOs include appetite stimulation, improvement of enzyme secretion related to food digestion, and immune response activation (Krishan and Narang, 2014).

A wide variety of herbs and spices (thyme, oregano, cinnamon, rosemary, marjoram, yarrow, garlic, ginger, green tea, black cumin, and coriander, among others), as well as EOs (from thyme, oregano, cinnamon, garlic, anise, rosemary, citruses, clove, ginger), have been used in poultry, individually or mixed, for their potential application as AGP alternatives (Gadde et al., 2017).

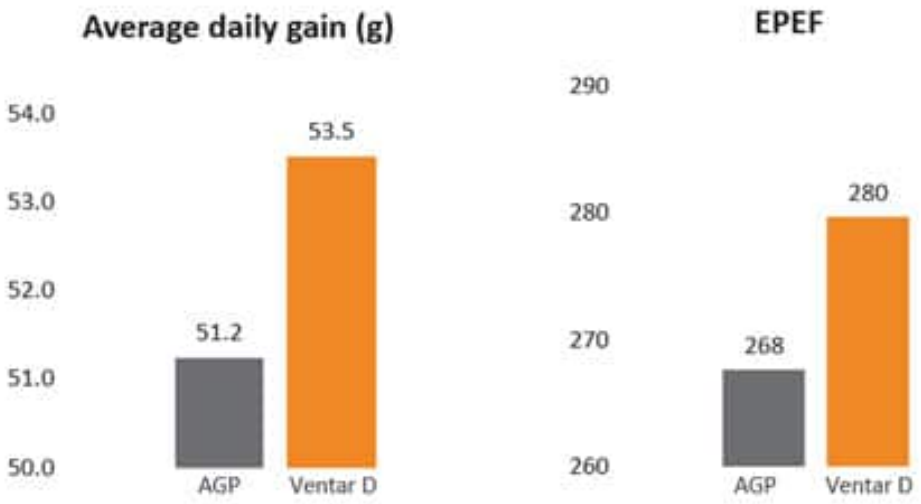


Fig. 3: Phytomolecule-based feed additive outperforms AGPs with improved broiler performance (42 Days field study)

One of the primary modes of action of EOs is related to their antimicrobial effects which allow for controlling potential pathogens (Mohammadi and Kim, 2018).

Phytomolecule blend	*Clostridium perfringens*	*Enterococcus caecorum*	*Enterococcus hirae*	*Escherichia coli*	*Salmonella typhimurium*	*Staphylococcus aureus*
Ventar D	1250	2500	5000	2500	5000	2500

Fig. 4: Effectivity of phytomolecule-based feed additive (Ventar D) against enteropathogenic bacteria (MIC value in PPM)

Phytomolecules have been shown to have anti-inflammatory properties. These compounds include flavonoids, polyphenols, carotenoids, and terpenes, among others. One of the ways in which phytomolecules exhibit anti-inflammatory effects is through their ability to inhibit the activity of pro-inflammatory enzymes and molecules. For example, polyphenols have been shown to inhibit the activity of nuclear factor-kappa B (NF-kB), a transcription factor that plays a key role in regulating inflammation.

Phytomolecules also have antioxidant properties, which can help to protect cells from damage caused by reactive oxygen species (ROS) and other reactive molecules that can contribute to inflammation. Plant extracts are also proposed to be used as antioxidants in animal feed, protecting animals from oxidative

damage caused by free radicals. The presence of phenolic OH groups in thymol, carvacrol, and other plant extracts act as hydrogen donors to the peroxy radicals produced during the first step in lipid oxidation, thus retarding the hydroxyl peroxide formation (Farag et al., 1989, Djeridane et al., 2006). Thymol and carvacrol are reported to inhibit lipid peroxidation (Hashemipour et.al. 2013) and have strong antioxidant activity (Yanishlieva et al., 1999).

Overall, the anti-inflammatory effects of phytomolecules are thought to be due to a combination of their ability to inhibit the activity of pro-inflammatory enzymes and molecules, their antioxidant properties, and their ability to modulate the immune system. Plant extracts (i.e. carvacrol, cinnamaldehyde, eugenol. etc.) inhibit the production of pro-inflammatory cytokines and chemokines from endotoxin-stimulated immune cells and epithelial cells (Lang et al., 2004, Lee et al., 2005, Liu et al., 2020). It has been indicated that anti-inflammatory activities may be partially mediated by blocking the NF-κB activation pathway (Lee et al., 2005).

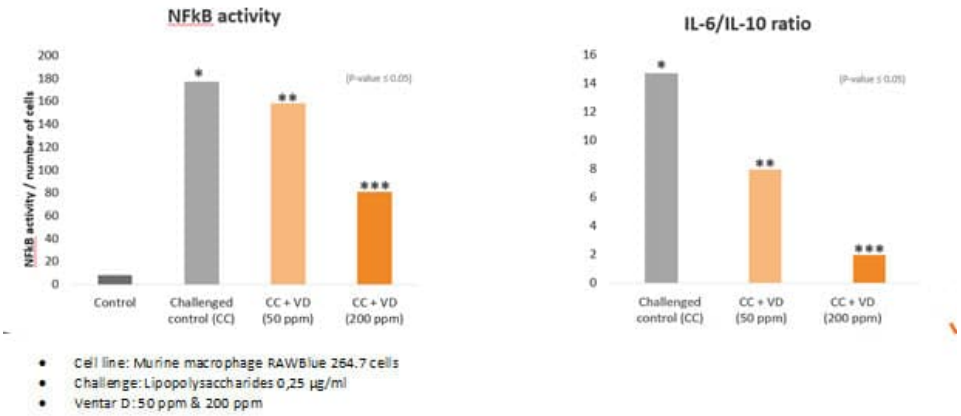


Fig. 5: Anti-inflammatory effect of phytomolecule-based feed additive (Ventar D) – the reduced activity of inflammatory cytokines

Proper protection of EOs/Phytomolecules is key to optimum results

Several phytogenic compounds have also been shown to be largely absorbed in the upper GIT, meaning that without proper protection, the majority would not reach the lower gut where they would exert their major functions (Abdelli et al. 2021). The benefits of supplementing the broiler diet with a mixture of encapsulated EOs were higher than the tested PFA in powdered, non-protected form (Hafeez et al. 2016). Novel delivery technologies have been developed to protect PFAs from the degradation and oxidation process during feed processing and storage, ease the handling, allow a slower release, and target the lower GIT (Starčević et al. 2014). The specific protection techniques used during the commercial production of an EO/phytomolecule blend are crucial in delivering on all the objectives with remarkable consistency.

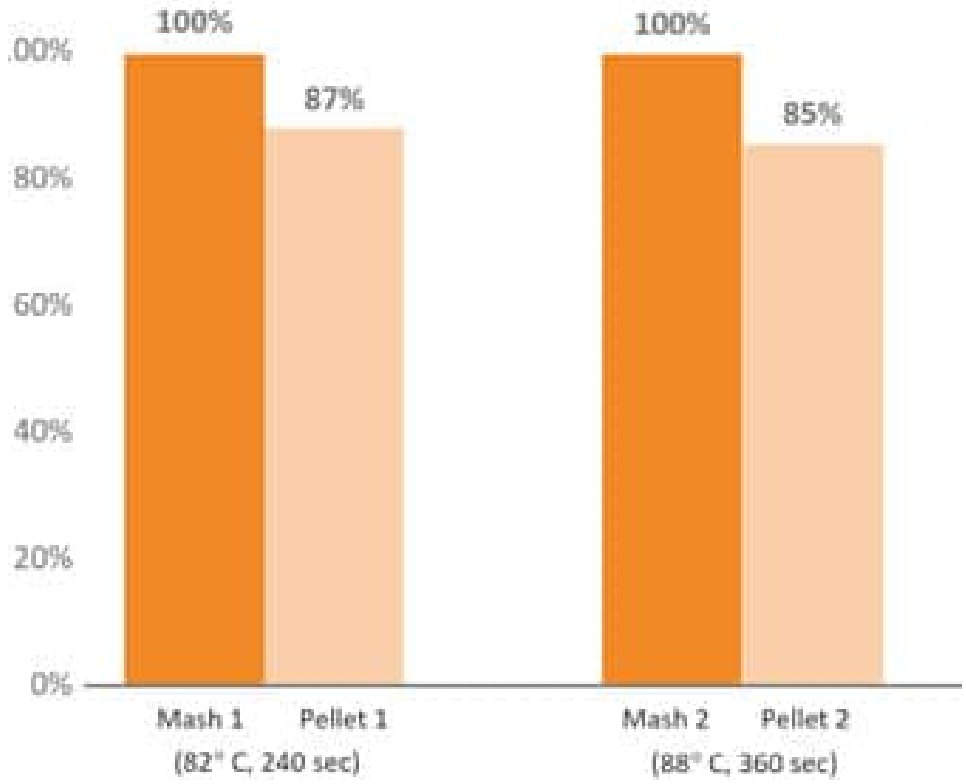


Fig. 6: Pelleting stability of phytomolecule – based feed additive (Ventar D) at high temperature and longer conditioning time

Phytomolecule blend optimizes production performance

Removal of antibiotics in poultry production can be challenging for controlling mortality and maintaining the production performance of the birds. Phytogenic feed additives have been shown to improve production performance of chicken due to their antimicrobial, anti-inflammatory, antioxidant, and digestive properties. Possible mechanisms behind improved nutrient digestibility by phytogenic feed additives (PFAs) supplementation could be attributed to the ability of these feed additives to stimulate appetite, saliva secretion, intestinal mucus production, bile acid secretion, and activity of digestive enzymes such as trypsin and amylase as well as to positively affect the intestinal morphology (Oso et al. 2019). EOs are perceived as growth promoters in poultry diets, with strong antimicrobial and anticoccidial activities (Zahi et al., 2018). PFAs have positive effects on body weight gain and FCR in chickens (Khattak et al. 2014, Zhang et el. 2009).

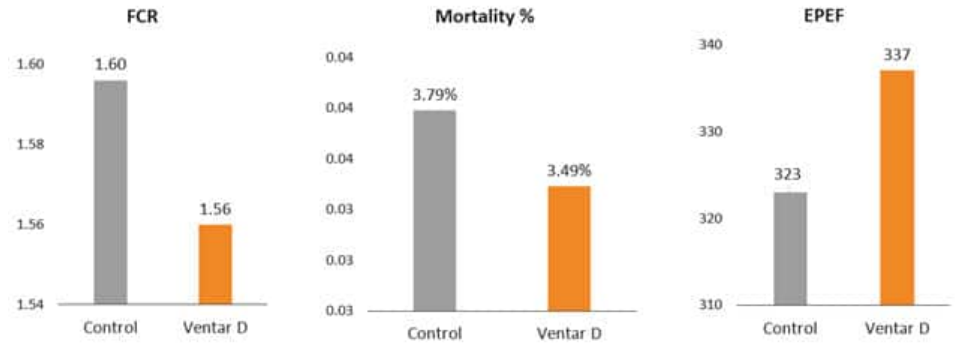


Fig. 7: Phytomolecule-based feed additive improved broiler FCR and mortality in field trial

Conclusion

In conclusion, managing gut health is a significant challenge in ABF broiler production that must be addressed to achieve optimal performance and welfare of the birds. The use of antibiotics as a preventative measure in broiler production has been widely used, but with the increasing demand for antibiotic-free products, alternative methods to maintain gut health must be implemented. These include using gut health-supporting feed additives, and proper management practices such as implementing biosecurity measures, maintaining optimal environmental conditions, providing adequate space and ventilation, and reducing stress. However, it is essential to note that there is no one-size-fits-all solution for gut health management in ABF broiler production. It is important to continuously monitor and assess their flock's gut health and make adjustments as necessary. Additionally, research and development in this field should be encouraged to identify new and innovative ways to maintain gut health in ABF broiler production.

Overall, managing gut health is a critical challenge that requires a multi-faceted approach and ongoing monitoring and management. By implementing the appropriate strategies and utilizing new technologies, poultry operators can ensure the health and well-being of their flocks while meeting the growing demand for antibiotic-free products sustainably.

References:

Abdelli N, Solà-Oriol D, Pérez JF. Phytogenic Feed Additives in Poultry: Achievements, Prospective and Challenges. Animals (Basel). 2021 Dec 6;11(12):3471.

Bailey R. A. 2010. Intestinal microbiota and the pathogenesis of dysbacteriosis in broiler chickens. PhD thesis submitted to the University of East Anglia. Institute of Food Research, United Kingdom

Choct M. Managing gut health through nutrition. British Poultry Science Volume 50, Number 1 (January 2009), pp. 9—15.

De Gussem M, "Coccidiosis in Poultry: Review on Diagnosis, Control, Prevention and Interaction with Overall Gut Health," Proceedings of the 16th European Symposium on Poultry Nutrition, Strasbourg, 26-30 August, 2007, pp. 253-261.H.J. Dorman, S.G. Deans. Antimicrobial agents from plants: antibacterial activity of plant volatile oils. J Appl Microbiol, 88 (2000), pp. 308-316

Djeridane A., M. Yousfi M, Nadjemi B, Boutassouna D., Stocker P., Vidal N. Antioxidant activity of some Algerian medicinal plants extracts containing phenolic compounds. Food Chem, 97 (2006), pp. 654-660

Farag R. S., Daw Z.Y., Hewedi F.M., El-Baroty G.S.A. Antimicrobial activity of some Egyptian spice essential oils. J Food Prot, 52 (1989), pp. 665-667

Gadde U., Kim W.H., Oh S.T., Lillehoj H.S. Alternatives to antibiotics for maximizing growth performance and feed efficiency in poultry: A review. Anim. Health Res. Rev. 2017;18:26–45.

Guo, F.C., Kwakkel, R.P., Williams, B.A., Li, W.K., Li, H.S., Luo, J.Y., Li, X.P., Wei, Y.X., Yan, Z.T. and Verstegen, M.W.A., 2004. Effects of mushroom and herb polysaccharides, as alternatives for an antibiotic, on growth performance of broilers. *British Poultry Science*, *45*(5), pp.684-694.

Hafeez A., Männer K., Schieder C., Zentek J. Effect of supplementation of phytogenic feed additives (powdered vs. encapsulated) on performance and nutrient digestibility in broiler chickens. Poult. Sci. 2016;95:622–629.

Hammer K.A., Carson C.F., Riley T.V. Antimicrobial activity of essential oils and other plant extracts. J Appl Microbiol, 86 (1999), pp. 985-990

Hashemipour H, Kermanshahi H, Golian A, Veldkamp T. Effect of thymol and carvacrol feed supplementation on performance, antioxidant enzyme activities, fatty acid composition, digestive enzyme activities, and immune response in broiler chickens. Poultry Science. Volume 92. Issue 8. 2013, Pp 2059-2069,

Khattak F., Ronchi A., Castelli P., Sparks N. Effects of natural blend of essential oil on growth performance, blood biochemistry, cecal morphology, and carcass quality of broiler chickens. Poult. Sci. 2014;93:132–137

Kraehenbuhl, J.P. & Neutra, M.R. (1992) Molecular and cellular basis of immune protection of mucosal surfaces.

Physiology Reviews, 72: 853–879.Krishan and Narang J. Adv. Vet. Anim. Res., 1(4): 156-162, December 2014

Lang A., Lahav M., Sakhnini E, Barshack I., Fidder H. H., Avidan B. Allicin inhibits spontaneous and TNF-alpha induced secretion of proinflammatory cytokines and chemokines from intestinal epithelial cells. Clin Nutr, 23 (2004), pp. 1199-1208

Lee S.H., Lee S.Y., Son D.J., Lee H., Yoo H.S., Song S. Inhibitory effect of 2′-hydroxycinnamaldehyde on nitric oxide production through inhibition of NF-kappa B activation in RAW 264.7 cells Biochem Pharmacol, 69 (2005), pp. 791-799

Liu, S., Song, M., Yun, W., Lee, J., Kim, H. and Cho, J., 2020. Effect of carvacrol essential oils on growth performance and intestinal barrier function in broilers with lipopolysaccharide challenge. Animal Production Science, 60(4), pp.545-552.

Mitsch, P., Zitterl-Eglseer, K., Köhler, B., Gabler, C., Losa, R. and Zimpernik, I., 2004. The effect of two different blends of essential oil components on the proliferation of Clostridium perfringens in the intestines of broiler chickens. Poultry science, 83(4), pp.669-675.

Mohammadi Gheisar M., Kim I.H. Phytobiotics in poultry and swine nutrition—A review. Ital. J. Anim. Sci. 2018;17:92–99.

Oso A.O., Suganthi R.U., Reddy G.B.M., Malik P.K., Thirumalaisamy G., Awachat V.B., Selvaraju S., Arangasamy A., Bhatta R. Effect of dietary supplementation with phytogenic blend on growth performance, apparent ileal digestibility of nutrients, intestinal morphology, and cecal microflora of broiler chickens. Poult. Sci. 2019;98:4755–4766

Oviedo-Rondón, Edgar O., et al. “Ileal and caecal microbial populations in broilers given specific essential oil blends and probiotics in two consecutive grow-outs.” *Avian Biology Research* 3.4 (2010): 157-169.

Petersen C. and June L. Round. Defining dysbiosis and its influence on host immunity and disease. Cellular Microbiology (2014)16(7), 1024–1033

Starčević K., Krstulović L., Brozić D., Maurić M., Stojević Z., Mikulec Ž., Bajić M., Mašek T. Production performance, meat composition and oxidative susceptibility in broiler chicken fed with different phenolic compounds. J. Sci. Food Agric. 2014;95:1172–1178.

Yanishlieva, N.V., Marinova, E.M., Gordon, M.H. and Raneva, V.G., 1999. Antioxidant activity and mechanism of action of thymol and carvacrol in two lipid systems. *Food Chemistry*, *64*(1), pp.59-66.

Yegani, M. and Korver, D.R., 2008. Factors affecting intestinal health in poultry. Poultry science, 87(10), pp.2052-2063.

Zhai, H., H. Liu, Shikui Wang, Jinlong Wu and Anna-Maria Kluenter. “Potential of essential oils for poultry and pigs.” Animal Nutrition 4 (2018): 179 – 186.

Zhang G.F., Yang Z.B., Wang Y., Yang W.R., Jiang S.Z., Gai G.S. Effects of ginger root (Zingiber officinale) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. Poult. Sci. 2009;88:2159–2166.

Rancidity in fats and oils:

Considerations for analytical testing

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

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

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

How does oxidative rancidity occur?

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

Oxidation: a three-step process

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

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

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

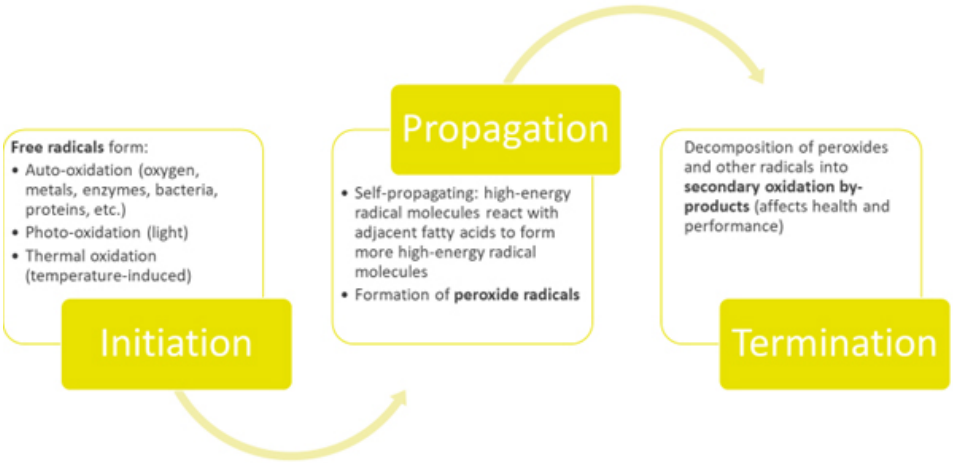


Fig. 1: Oxidation: a three-phase series of reactions

Antioxidants preserve the quality of rendered products

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

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

Rancidity testing

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

There are several methods used for rancidity testing, including:

Organoleptic rancidity testing

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

Chemical & instrumental rancidity testing

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

Peroxide value

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

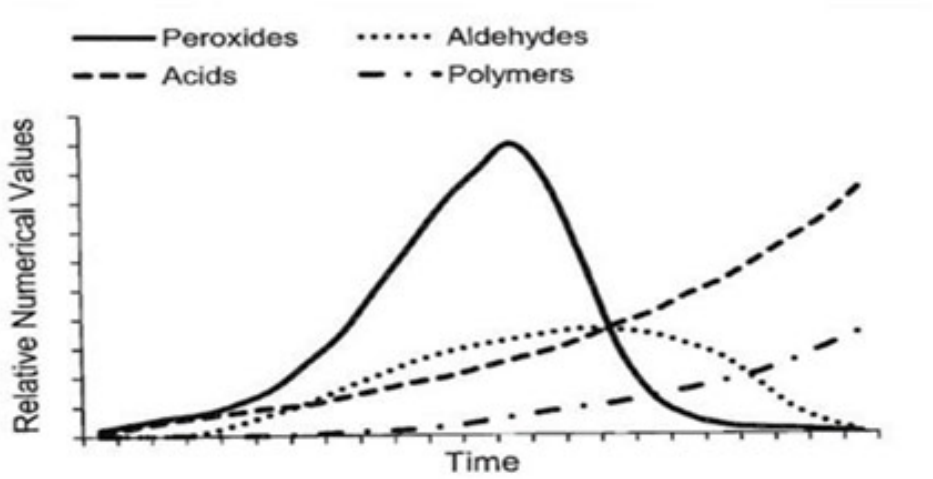


Fig.2: Oxidation products changes with time

p-Anisidine (p-AV)

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

TBARS

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

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

Gas chromatography

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

Fourier-transform infrared spectrophotometer (FTIR)

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

Free Fatty Acids (FFA)

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

Oxidative Stability Index (OSI)

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

Analytical testing considerations in rendering operations

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

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

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

Table. 1: Analytical testing considerations for rendering

Conclusion

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

Shrinkage: Causes, dangers, solutions

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

In light of sustainability requirements, shortage of feed materials, and constant pressure on energy efficiency, we must rethink how we deal with all elements that impact our production. Shrinkage is one of the essential impacting elements.

What is Shrinkage?

In simple terms, shrinkage is the weight loss in feed or feed materials during receiving, processing, or storage. Shrinkage happens on the farm level but also in feed mills. In this article, we will focus on the latter one. Points or reasons why this happens are diverse but not unknown. Wastages, dust, pests, moisture loss, and scale deviations are some of the most important. Through time, we found efficient ways to close the doors to feather and fur pests that were stealing valuable resources and causing shrinkage.

We are also good at weight control when receiving and dispatching, by thoroughly balancing the scales. But one point related to the core of feed production – and the most significant loss – is still left untackled. That is moisture loss through grinding.

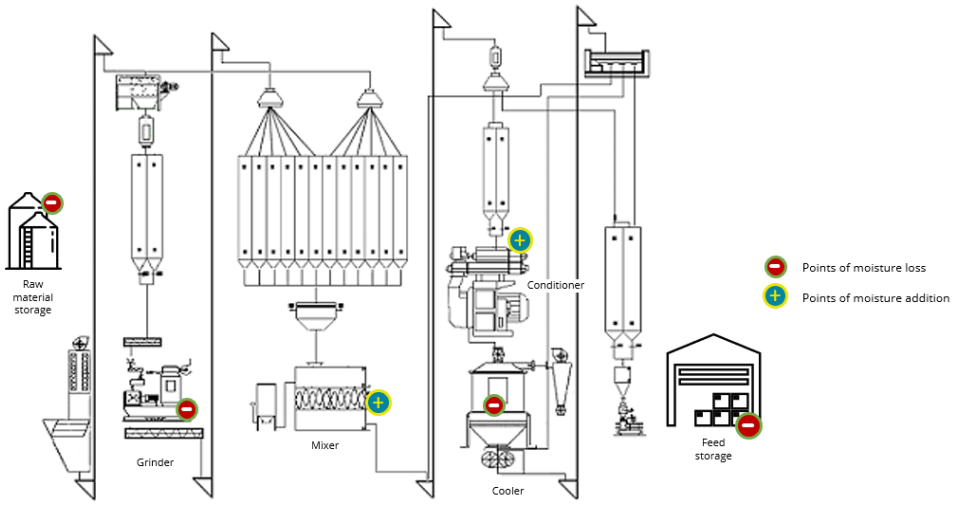


Figure 1: Points of moisture loss and addition in the feed mill

Grinding is one central point of shrinkage

Grinding and subsequent particle size reduction is essential from many points (handling, nutritional, processing, mixing uniformity, …) and is unavoidable if we want to produce excellent feed. In the case of grinding with hammer mills, we use kinetic energy to make the hammers beat kernels to the desired size. This is a very efficient process. However, during that process, a part of kinetic energy is also transferred to thermal, increasing the temperature of the processed feed materials and resulting in the loss of one part of valuable moisture. Also, due to size reduction and enlargement of the surface, there is much more place for evaporation and moisture movement. **Losses can be up to 2%**. One essential parameter for high pellet quality is the particle size, but very fine grinding will result in higher shrinkage through moisture and dust losses.

Moisture is decisive– we must manage it!

The valuable moisture is needed for many reasons. One is weight. Another reason is that nutritional density for feed materials is calculated considering a certain moisture content. Additionally, moisture influences the processing parameters during the pelleting process (targeted moisture content in the conditioner should be 16-18%). Since moisture loss is unavoidable and represents the most significant part of loss or shrinkage, we must manage it. For this purpose, we must substitute lost moisture with added moisture. And in that process, we have a short time to do it properly. Usually, we don´t have enough time for so-called “soaking”. However, with the help of surfactants, the process can be speeded up.

Surf-Ace helps to keep the moisture in the feed

Surf-Ace, a liquid preservative premix for moisture optimization, which contains organic acids / organic acid salts, emulsifiers, and surfactants, helps to keep the moisture in the feed. Conditioning can be hindered by surface tension because water forms a film on the surface of the feed particles, or oil covers the particles. Surf-Ace improves water penetration and retention by decreasing surface tension. Trials show the moisture-optimizing effect of Surf-Ace.

A trial conducted in Jordan demonstrated an increase in moisture in different processing phases (feeder, heater, and the final product). It also showed better maintenance of water in the product during storage (Fig. 2).

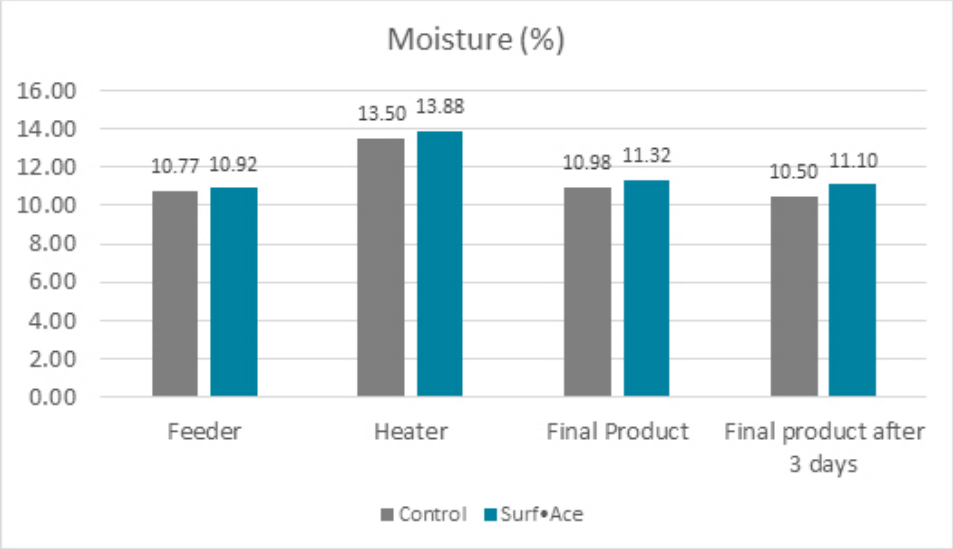


Figure 2: Surf-Ace achieved higher moisture levels in different phases of the feed production process

Two further trials conducted in Poland and Serbia also showed that feed millers could increase moisture in the final feed by using Surf-Ace (Fig. 3).

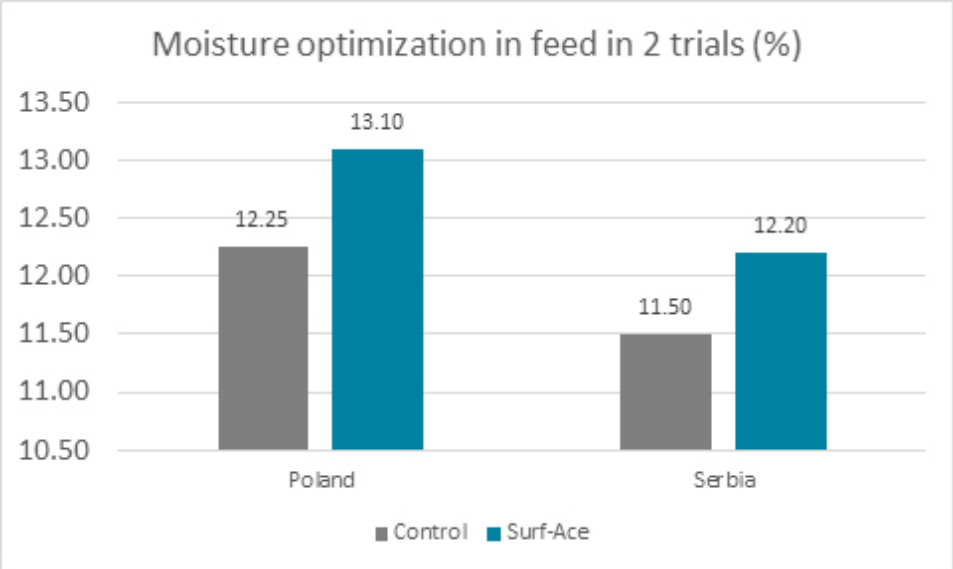


Figure 3: Surf-Ace provided for higher moisture content in the feed

Effective surfactants minimize shrinkage in feed

Shrinkage in times of increasing costs must be minimized by all means. The feed industry offers surfactants that keep the moisture in the feed during processing and prevent at least this part of shrinkage.

Besides the financial aspect, the optimal moisture content in feed and feed materials is important to provide high feed quality, whether concerning pellet quality or percentage of nutrients. Using surfactants, therefore, not only increases profitability but also does its bit concerning sustainability.

Xylanase solutions for broiler feed: Enzyme innovation finally hits the market

*By **Dr. Ajay Awati**, Global Category Manager for Gut Health and Nutrition, EW Nutrition, and **Dr. Howard Simmins**, InSci Associates*

After 30 years of stagnating solutions, in-feed xylanase innovation has finally arrived – with a complete focus on the needs of the broiler feed industry.

It has been over 30 years since xylanase was first introduced in broiler diets in Europe. In the meantime, it has been widely used worldwide with few, if any, major improvements. While the animal feed industry evolved in terms of production landscape, feed processing technologies and use of various by-products, xylanase enzyme technology did not keep pace. In fact, it did not evolve to meet customers' changing needs and provide that much-needed flexibility of diet formulation for a commercial nutritionist. The wait is over: new in-feed xylanase technology is about to revolutionize broiler nutrition.

Why we need innovative xylanase enzymes for broiler production

Initially, in the 1980s, xylanase was leveraged from industries unrelated to animal production into the feed business. Gut viscosity had been a continuing problem in broiler chickens fed wheat-based diets. It led to an increased risk of enteric disease, generally reducing performance. Xylanase was shown to reduce gut viscosity in wheat-based feed by breaking down soluble arabinoxylans.

As a result, the birds grew as well as if they were fed a low-viscosity corn/soya diet. An additional benefit was lower disease risks from the reduced level of anti-nutritional factors (ANFs) and the multiple negative effects of viscosity in the intestine.

In addition to reducing viscosity, xylanase augments the release in the small intestine of nutrients from previously undigested feedstuffs. The outcome has been the use of an energy matrix value for xylanase, which essentially helps diets through least-cost formulation.

These effects account for the growth of xylanase use in the monogastric feed market. Today, the penetration is above 50%.

Limitations of existing xylanase solutions

Leveraging xylanases from other industries for viscosity reduction in poultry comes with a couple of distinct limitations:

1. Most broiler diets around the globe are based on a corn-soybean formulation, which contains far higher levels of insoluble arabinoxylans than soluble arabinoxylans. In such cases, viscosity is a relatively minor issue compared to the anti-nutritional effect of insoluble arabinoxylans.
2. The reduction of gut viscosity is less relevant in other poultry sectors, such as laying hens and turkeys.

Commercial xylanases would be required to **break down insoluble NSPs** in which substrate activity may be limited and difficult to predict. Fiber constituents of different cereal grains used in feed are highly variable. By- and co-products derived from cereals contain even more complex fiber components, altered further by the manner of processing that the raw material has undergone.

Additionally, poultry response is highly variable: For an individual bird, the effectiveness of xylanase depends on the enzyme’s interaction with feed in the gastrointestinal tract (GIT) of the animal, which varies depending on the species and the animal’s age. This may explain why xylanase penetration on the feed market is not as high as that of phytase.

GH10: the next-level xylanase for feed application

A xylanase for feed is required to provide multiple functionalities, of which four are essential:

1. Capacity to break down soluble and insoluble arabinoxylan across a range of typical feedstuffs
2. Rapid activity at optimal pH in the preferred section of the GIT
3. No inhibition in the presence of xylanase inhibitors
4. Comprehensive feed processing thermostability

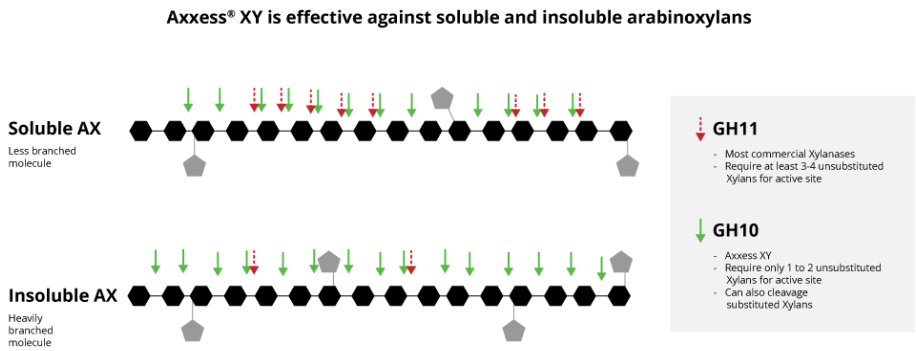
The GH11 family of xylanases commonly used in feed does not offer these aggregated benefits. They successfully reduce soluble NSPs in wheat-based diets, hence lowering the viscosity level in the broiler GIT. However, they are less effective in the presence of insoluble NSPs in which the arabinoxylan backbone is more complex.

Why GH10 instead of GH11?

The explanation for this can be found in the 3-dimensional structure of the GH11 xylanase. The activity of GH11 xylanases requires 3 or 4 consecutive unsubstituted xylan monomers on the backbone to find an active site. That is why they are hindered by the presence of branches, or side chains, on arabinose backbones. Consequently, they are highly specific, favoring the particularly low-branching wheat backbone.

Xylanases from the GH10 family are entirely different. Although well known, they have not been used in feed yet. The GH10 xylanases require two or fewer consecutive unsubstituted xylan monomers on the backbone to find an active site. Therefore, they can act on xylose residues near branches. This results in both more and shorter xylo-oligomers than found with GH11 xylanases. In simple terms, the GH10 xylanases have a less deep cleft than the GH11 xylanases, providing greater catalytic versatility (Pollet 2010).

Significantly, this potentially allows a broader range of feedstuffs to be incorporated into the complete diet, including co- and by-products, while maintaining performance. Therefore, **with GH10, higher levels of cheaper ingredients may be included, with a significant value proposition of further reducing feed costs.**



GH10 xylanases generate a range of important prebiotics

As early as 1995, it was proposed that xylanase may affect microbial activity in the gastrointestinal tract through the provision of fermentable oligosaccharides and low molecular weight polysaccharides. These are produced from the hydrolysis of soluble and insoluble arabinoxylans in cereals.

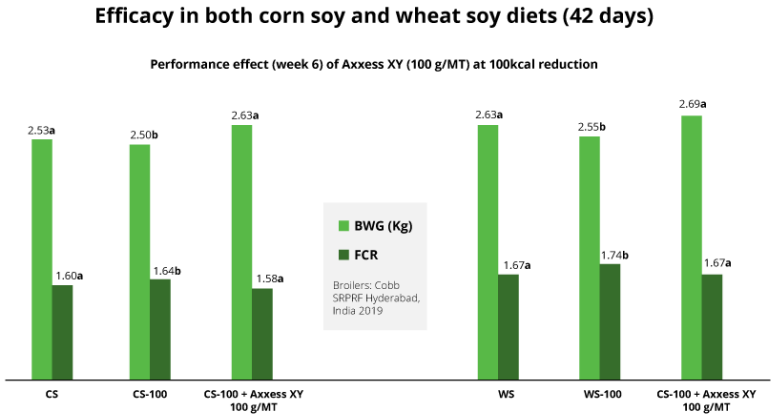
A development of particular interest is that the GH10 xylanases break down the backbone of different fibre components into small xylooligosaccharides (XOS) and arabino-xylanoligosaccharides (AXOS). This action, research shows, has value in supporting the selective growth of fibre-degrading bacteria in the large intestine, conferring positive effects on the host's health.

The most well-known probiotic strains belong to bifidobacteria and lactobacilli, which have quite different XOS and AXOS utilization systems. *Bifidobacterium adolescentis* has been shown to consume AXOS and XOS, whereas *Lactobacillus brevis* utilises only XOS. The outcome is that AXOS releases butyrate, the short-chain fatty acid, which can improve the host's gut barrier function, as well as reduce Salmonella colonization in broilers. Alongside these health benefits, their presence may improve performance also by reducing FCR. (Courtin et al. 2008; Ribeiro et al. 2018)

As mentioned earlier, the GH10 xylanase requires only two consecutive unsubstituted xylan monomers to cleave the xylan main chain, whereas a GH11 xylanase requires 3 or 4 consecutive unsubstituted xylan monomers. Therefore, the number of potential AXOS and XOS oligomers is higher from the action of the GH10 xylanase. This results in a wider size range of oligomers. The range is valuable as the effect is

spread across the large intestine, each oligomer having a different fermentation rate. Consequently, the large intestine's microbial activity becomes saccharolytic, which potentially reduces the undesirable products of proteolytic degradation, such as phenols and cresols.

Prebiotic combinations will vary depending on the substrate available. However, there is more flexibility in breaking down insoluble NSPs across different feedstuffs using GH10 xylanase compared to GH-11 xylanase.



The future of xylanase: Reducing feed costs through flexible formulation

EW Nutrition's GH10-based AXXESS XY xylanase, specifically developed for animal feed, has a wide-ranging activity across typical substrates, both in corn-soy and wheat-soy diets. It also allows for a greater proportion of cheaper ingredients, enabling increased flexibility in feedstuff choices and resulting in more stable feed pricing. The activity of the GH10 xylanase in producing oligomers from the breakdown of the arabinoxylan backbone also indicates that it can produce a greater number and diversity of valuable prebiotics that sustain the growth of fiber-degrading microbiota. Consequently, the metabolism of the large intestine is shifted from proteolytic to saccharolytic, which supports the animal's general health.

The combination of these benefits from using this xylanase results in a bird with a balanced digestive system that is more robust in the face of environmental and health challenges, supporting better performance. Furthermore, **this novel enzyme solution gives nutritionists a reliable tool to reduce feed costs by being flexible in diet formulation and opportunistic in using raw materials while maintaining consistency in animal performance**. Especially in these times of supply problems and raw material price hikes, such advantages are invaluable.

The naturally thermostable AXXESS XY 1000G is the most advanced xylanase yet. It is a GH10 xylanase that delivers what the industry has been asking for: a fiber-degrading enzyme suited for all poultry feed.

References

Courtin, Christophe M, Katrien Swennen, Willem F Broekaert, Quirine Swennen, Johan Buyse, Eddy Decuypere, Christiaan W Michiels, Bart De Ketelaere, and Jan A Delcour. "Effects of Dietary Inclusion of Xylooligo-Saccharides, Arabinoxylooligosaccha- Rides and Soluble Arabinoxylan on the Microbial Composition of Caecal Contents of Chickens." *Journal of the Science of Food and Agriculture* 88, no. 14 (2008): 2517–22. https://doi.org/10.1002/jsfa.3373.

Ribeiro, T., V. Cardoso, L.M.A. Ferreira, M.M.S. Lordelo, E. Coelho, A.S.P. Moreira, M.R.M. Domingues, M.A. Coimbra, M.R. Bedford, and C M Fontes. "Xylo-Oligosaccharides Display a Prebiotic Activity When Used to Supplement Wheat or Corn-Based Diets for Broilers." *Poultry Science* 97, no. 12 (2018): 4330–41. https://doi.org/10.3382/ps/pey336.

Pollet, Annick. “Functional and Structural Analysis of Glycoside Hydrolase Family 8, 10 and 11 Xylanases with Focus on Bacillus Subtilis Xylanase A,” 2010.
https://www.biw.kuleuven.be/m2s/clmt/lmcb/publications/docs/apollet

---

Coughing calves? How to save costs and prevent respiratory disease

*By **Judith Schmidt**, Product Manager On Farm Solutions*

There will always be germs in barns. Yet, calves are particularly susceptible to lung viruses and bacteria that attack the respiratory systems. What can we do to prevent calf flu?

Coughing in calves is one of the most obvious signs of illness. It should be taken seriously – calves are important for the profitability of farms. Calf flu not only leads to treatment costs but also has long-term consequences, such as weak daily gains, delayed lactation, lower milk yield, reduced fertility, and increased susceptibility to other diseases.

Respiratory disease in calves: recognize the symptoms and protect their lung health

Calves are much more sensitive to respiratory diseases than many other animals. Why? One major cause is that calves are born with immature lungs. The lungs are only fully developed at about one year of age. In addition, calves generally have small lungs relative to their body size. Furthermore, the immunological gaps around the second month of life are decisive. During this phase, the number of maternal antibodies in the calf´s blood decreases, while the calf´s own immune system is still slowly building up.

Symptoms of calf flu

1) Cough

A very easy-to-recognize sign of a developing calf flu is coughing. Coughing can also be caused by changes in weather, stress, or an unsuitable barn climate, but coughing should always be monitored, and animals should be checked for other symptoms.

2) Respiratory distress

Sick calves breathe heavily and show an increased respiratory rate. Even at rest, this can be more than forty breaths per minute, ranging from a slight acceleration of breathing to severe respiratory distress and breathing through the open mouth. Mouth breathing can be the first indication of lung damage.

3) Eye and nose discharge

Calf flu not only shows its symptoms in the internal respiratory tract but also in the eyes and nose through clear, watery discharge. In later stages, bacterial infections can also cause purulent discharge. The animal’s gaze is not clear and rather “sleepy.”

4) Body posture

Calf flu often manifests itself by drooping ears or an overall low head posture, as the calves are dull and weak. They are inactive and separate themselves from the group. They also lie down and standing up is delayed.

5) Reduced water and feed intake

Due to their physical condition, animals suffering from flu tend to take in only little feed and water or do not eat and/or drink at all. The logical consequence is a weakening of the animals. In case of doubt, one should actively water and feed the animals.

Economic significance of respiratory disease in calves

Influenza in cattle and calves is a herd disease and often causes serious financial losses. Losses are caused by pronounced performance decreases, developmental disorders of the animals, and treatment costs. Significantly reduced daily gains have been demonstrated for fattening animals.

Next to diarrheal diseases, calf flu causes the highest treatment and follow-up costs for calves. A study by the Chamber of Agriculture of Lower Saxony (Germany) found that farmers had to spend between 83 and 204 euros per sick calf, depending on the severity of the disease.

4 tips to save costs and tackle calf flu with less antibiotics use

1) Offer a stable climate

Warm, damp barns, as well as overcrowded and poorly ventilated ones, weaken the calf´s defense mechanisms. Temperature fluctuations of more than 10°C between day and night also favor the development of calf flu. It is important to keep the calves' environment free of dust and draughts. This can be achieved by adjusting the air exchange rate.

In addition, the humidity in barns without a heating system should be between 60 and 80 percent. Data loggers help to keep an eye on the climate in the barn. They make it possible to check how the outdoor climate and ventilation affect the climate conditions in the barn.

2) Hygiene-sensitive calving management

Attention should be paid to calving management. The long-term health of the animal is already predetermined in the calving pen. If several cows calve at the same time or if calving pens are not mucked out regularly, harmful germs will accumulate. In other words: if a calf is born into a dirty box, it will absorb many germs through its mucous membranes.

3) Avoid stress

It is crucial to minimize stress from causes such as transport, re-housing, feed changes, group formation, dehorning, and weaning. These events should be spaced out as far as possible and should never occur simultaneously.

4) Prevention through supplementary feed

In the winter months, when the weather is cold and damp and constantly changing, calf flu incidence skyrockets. Now, it is imperative to strengthen the calf´s respiratory tract from the beginning. EW Nutrition's Bronchogol Liquid is a herbal concentrate that supports respiration and stabilizes the physiological defense system in the respiratory organs.

Bronchogol liquid supports young calves in stressful situations, such as critical weather transition periods (autumn-winter; winter-spring) and housing changes, and when they suffer from calf flu. The product is based on a proprietary mixture of phytomolecules. By stimulating the cilia in the respiratory tract, the phytomolecules promote the transport of mucus and facilitate expectoration.

4 steps to improve dairy cow fertility through feeding

*By **Judith Schmidt**, Product Manager On Farm Solutions*

The average pregnancy rate for dairy cows has declined over the past decades. But why is my cow not getting pregnant? Is it because of feeding? These are questions we ask ourselves when things do not quite work out with the offspring in the cowshed. Economic success in the cow barn is closely related to the successful reproduction of our cattle herd.

The maintenance and possible improvement of fertility are becoming increasingly important issues for farm productivity. Infertility is still one of the main reasons for culling on dairy farms. When farmers decide to cull a cow after a few unsuccessful inseminations, they often ask themselves whether this could not have been prevented. There is no “all-encompassing” solution for achieving an optimal fertility rate, which ultimately requires excellent management. Relevant factors include oestrus monitoring and insemination timing, genetic conditions, feeding, hygiene, and climate.

How can I tell if a cow is in heat?

A cow behaves differently than usual during oestrus. She is restless and walks around more. A cow in heat stands next to other cows – head to tail. Sie also quarrels with her herd mates or sniffs at the shame of the other cows. Fertility in cows decreases during late winter and spring; the resulting absence of clear signs of oestrus makes it difficult to recognize the right time for insemination. There are several possible causes which will be reviewed below.

Possible causes of fertility problems in dairy cows

Beta-carotene deficiency

A productive herd needs to receive an optimal mineral and trace element supply. Beta-carotene, in particular, is essential for herd fertility. But why?

Beta-carotene is an orange-yellow plant pigment whose name comes from “carrot” because of its appearance. It is also a precursor of vitamin A. Both as a precursor and as vitamin A itself, it is essential for the organism of humans and animals, particularly when it comes to the fertility of dairy cows. Besides its important function as provitamin A, beta-carotene also exerts an independent effect on the ovary. It influences the quality of the follicle and the corpus luteum. Beta-carotene also protects the corpus luteum. It promotes the synthesis of the pregnancy hormone progesterone and thus enables the fertilized egg to implant successfully in the uterine lining.

A beta-carotene deficiency can lead to the following problems:

- Smaller, not fully functional follicles
- Altered oestrus intervals
- Indistinct signs of oestrus
- Decreased corpus luteum quality

Scientific trials show how much a beta-carotene deficiency influences the fertility process. With a beta-carotene deficiency, the fertilization rate after the first insemination is only 40%, whereas with a normal beta-carotene supply, the fertilization rate is about 70%.

How do I know if my herd is deficient in beta-carotene?

The easiest way is to check the color of the fresh colostrum. If it is a deep yellow to an even orange, the cows are supplied with sufficient beta-carotene. If it looks more ivory, this is a sign of a deficiency. Of course, a poor herd fertilization rate can also indicate a deficiency. If you suspect a beta-carotene deficiency, it is best to test some blood samples from your animal or use a testing device such as a carotene photometer. With such a test kit, you can determine not only the levels in the blood but also in the colostrum and the milk.

Feeding deficiencies

Feeding plays a major role in fertility issues. Too low input rates often have a negative effect on the health of cows. Feed quality and herd management have an impact on how long the cow loses weight after calving and at what point she gains weight again. One must always keep in mind the cows' feeding, energy balance, and nutrient supply because cows with a negative energy balance often do not show oestrus. It is also important that the silage is of high quality – poor silage inhibits fertility.

Follicle quality

The quality of the follicle is crucial for good fertility. The quality is influenced by the energy supply during the dry period and lactation during the first days. Since the follicles are already formed in the last days of gestation, a lack of energy during this period means that the maturation of the follicles – even with a better supply later on – can no longer proceed optimally and is ultimately inferior. This inevitably leads to a reduction of oestrus symptoms and minimizes the chances of successful insemination.

Prevention is key: 4 steps to improve fertility through feeding

1) Avoid stress in the feeding environment

Well-being and a high feed intake are the basis for high milk and fattening yields as well as healthy and fertile animals. Dry cows and transit cows particularly should only experience low stress. This means no overcrowding and generous feeding space, i.e., each animal should have its own feeding space. Feeding areas that are too narrow prevent the animals from eating, rank fights occur, and feed intake decreases.

Freshly lactating cows should be separated from the group. If the cows are in calving pens or calving stables, they should always have visual contact with the herd.

2) Optimize feed quality and rations

Feed quality and feeding management determine how long the cow loses weight after calving (negative energy balance) and at what point the cow gains weight again (positive energy balance). Optimal fertility performance can only happen when a positive energy balance is achieved.

The cow’s fertility performance is primarily determined by nutrient supply and feeding. At the beginning of the lactation, high-quality basic feed with a high energy concentration should be fed, as feed intake is slow to get going after calving. Nevertheless, this ration should have sufficient structure. The amounts of concentrate should be divided into several individual portions and carefully increased. For high feed intakes, fresh water should be constantly available to the animals.

3) Treat diseases early to enable feeding

Diseases that lead to a reduced appetite should be treated as early as possible. In particular, attention should be paid to healthy hooves because a cow that has pain or difficulty getting up and walking is much less likely to go to the feed table.

4) Supplement vitamins, minerals, and trace elements

The needs-based supply of vitamins, minerals, and trace elements in every performance phase is a decisive success factor for good herd fertility. A sufficient supply of trace elements, especially selenium, manganese, zinc, as well as vitamin A and beta-carotene, are important for the formation of fertility hormones and optimal insemination success. At the same time, they ensure a high colostrum quality.

EW Nutrition’s Fertilgol Bolus is a long-term bolus to support fertility. The high content of beta-carotene has a positive influence on the formation of the corpus luteum, the oestrus cycle, the quality of colostrum and sperm. The release rate of the ingredients beta-carotene, selenium, vitamin A, and other trace elements takes place over at least twenty days. Fertilgol Bolus can be used for female and male breeding animals shortly before and during the breeding or insemination period.