Overcoming Challenges of Xylanase Inhibitors in Animal Feeds

By Dr. Ajay Awati, Global Director Enzymes, EW Nutrition

In recent years, the scientific understanding of xylanase inhibitors (XIs) and their impact on animal nutrition has grown significantly. Xylanase, a crucial enzyme used to enhance nutrient availability in feed, can face challenges from XIs present in cereal grains. This article explores the evolution of plant protection mechanisms, the economic impact of XIs, and the development of a novel xylanase, Axxess XY, resistant to these inhibitors.

Xylanase inhibitors – an evolutionary protection mechanism of plants

Xylanase inhibitors (XI) are a classic example of the evolutionary development of protection mechanisms by cereal plants against pathogens. Microorganisms, such as fungal pathogens, involve the degradation of xylan as one of the mechanisms in pathogenesis (Choquer et al., 2007). There are also other mechanisms by which microorganism-produced xylanases affect plants.

To protect themselves, plants evolved xylanase inhibitors to prevent the activities of xylanases. XIs are plant cell wall proteins broadly distributed in monocots. There are three classes of XIs with different structures and inhibition specificities (Tundo et al., 2022):

1. Triticum aestivum xylanase inhibitors (TAXI)
2. Xylanase inhibitor proteins (XIP), and
3. Thaumatin-like xylanase inhibitors (TLXI).

Xylanase inhibitors have an economic impact

In animal nutrition, xylanases are widely used in diets containing cereal grains and other plant materials to achieve a higher availability of nutrients. The inhibitory activity of XIs prevents this positive effect of the enzymes and, therefore, makes them economically relevant. Studies have reported that higher levels of XIs negatively impact broiler performance. For example, in one of the studies, broilers fed with grains of a cultivar with high inhibitory activity showed a 7% lower weight on day 14 than broilers fed with grains of a cultivar with less inhibitory activity (Madesen et al., 2018). Another study by Ponte et al. (2004) also concluded that durum wheat xylanase inhibitors reduced the activity of exogenous xylanase added to the broiler diets.

Xylanase inhibitors can withstand high temperatures

Even though XIs can impact the performance of exogenous xylanase in different ways, only minor attention was paid to the reduction of xylanase's susceptibility to xylanase inhibitors during the xylanase development in the last decades. Firstly, the issue was ignored mainly through the assumption that XIs are denatured or destroyed during pelleting processes. However, Smeets et al. (2014) showed that XIs could sustain significant temperature challenges. They demonstrated that after exposing wheat to pelleting temperatures of 80°C, 85°C, 92°C, and 95°C, the recovery of inhibitory activity was still 99%, 100%, 75%, and 54%, respectively. Furthermore, other studies also confirmed that conditioning feed at 70-90°C for 30 sec followed by pelleting had little effect on the XI activity in the tested feed, showing that xylanase inhibitors are very likely present in most xylanase-supplemented feeds fed to animals.

Do we only have the problem of xylanase inhibitors in wheat?

No. After first reports of the presence of xylanase inhibitors in wheat by Debyser et al. (1997, 1999), XIs were also found in other cereal grains (corn, rice, and sorghum, etc.), and their involvement in xylanase inhibition and plant defense has been established by several reports (Tundo et al., 2022).

In most of the countries outside Europe, exogenous xylanase is used not only in wheat but also in corn-based diets. Besides broiler feeds, also other animal feeds, such as layer or swine feed being part of more mixed-grain diets, are susceptible to the inhibitory activity of XIs. Nowadays, the situation is getting worse with all the raw material prices increasing and nutritionists tending to use other feed ingredients and locally produced cereals. They need a xylanase which is resistant to xylanase inhibitors.

Xylanases' resistance to XIs is crucial –

Axxess XY shows it

To prevent xylanases from losing their effect due to the presence of xylanase inhibitors, the resistance of new-generation xylanases to these substances is paramount in the development process, including enzyme discovery and engineering.

In the past 25 years, scientists have learned much about XI-encoding genes and discovered how xylanase inhibitors can block microbial xylanases. Additionally, there has been a significant increase in understanding the structural aspects of the interaction between xylanases and XIs, mainly how xylanase inhibitors interact with specific xylanases from fungi or bacteria and those in the GH10 or GH11 family. With such understanding, a new generation xylanase, Axxess XY, was developed. Besides showing the essential characteristics of intrinsic thermostability and versatile activity on both soluble and insoluble arabinoxylan, it is resistant to xylanase inhibitors.

Axxess XY takes xylanase application in animal feeds to the next level.

Axxess XY outperforms other xylanases on the market

Recent scientific developments (Fierens, 2007; Flatman et al., 2002; Debyser, 1999; Tundo et al., 2022; Chmelova, 2019) *and* internal research can be summarized as follows:

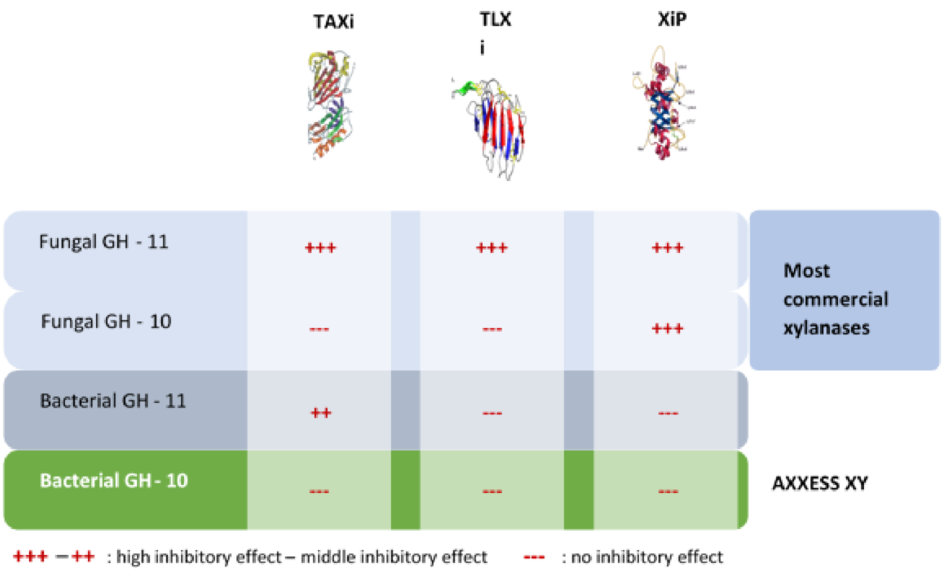

Figure 1: Schematic summary of the susceptibility of different xylanase to xylanase inhibitors from three main groups.

The high resistance to xylanase inhibitors is one of the reasons that a novel xylanase with bacterial origin and from the GH-10 family was chosen to be Axxess XY. EWN innovation, together with research partners, made an interesting benchmark comparison between xylanases that are commercially sold by different global suppliers and Axxess XY. For these trials, all xylanase inhibitors from wheat were extracted. The inhibitors, together with the respective xylanase, were incubated at 40^{0}C (to mimic birds' body temperature) for 30 mins. Then, the loss of xylanase activity was calculated by analyzing remaining activity after incubation. Results are shown below in Figure 2. There were varying levels of activity loss observed in the different commercially sold xylanases. In some xylanases, the losses were alarmingly high. However, Axxess XY was not inhibited at all.

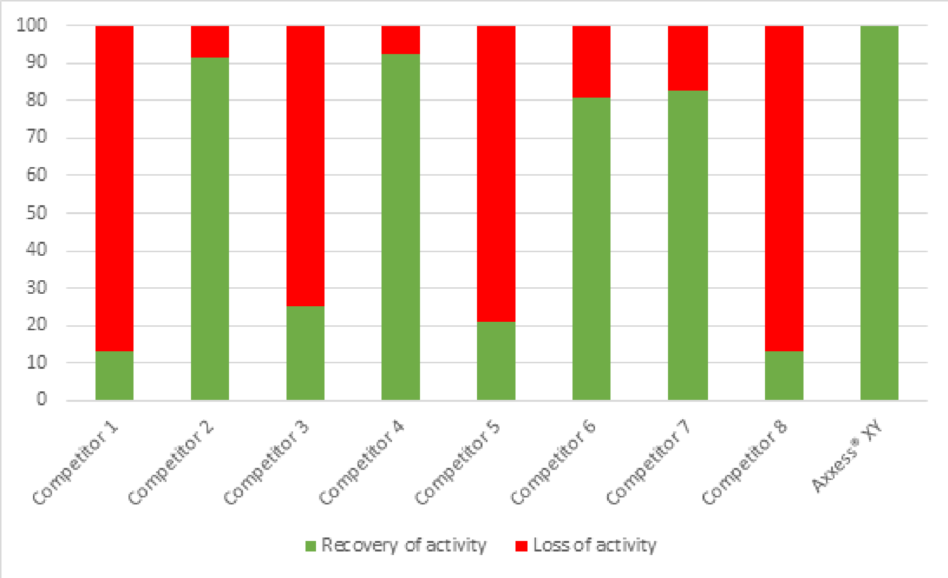

Fig. 2: Extracted total xylanase inhibitors from wheat incubated with the respective xylanase at 40°C for 30 mins. – Loss of activity after incubation with xylanase inhibitors

Conclusion:

Xylanase inhibitors are present in all cereal grains and, unfortunately, heat tolerant (up to 90^{0}C, still 75% of inhibition activity was retained). Regardless of the diets used, there is a possibility that the xylanase used may come across xylanase inhibitors, resulting in a loss of activity. More importantly, this can lead to inconsistent performance.

For effective, consistent, and higher performance of NSP enzyme application, it is a must to use xylanase that is resistant to xylanase inhibitors.

Literature:

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Debyser, W, WJ Peumans, EJM Van Damme, and JA Delcour. "Triticum Aestivum Xylanase Inhibitor (Taxi), a New Class of Enzyme Inhibitor Affecting Breadmaking Performance." *Journal of Cereal Science* 30, no. 1 (1999): 39–43. https://doi.org/10.1006/jcrs.1999.0272. LINK

Influence of nutrition and

management on eggshell quality

Conference report

Many factors affect eggshell quality, such as nutrition, disease, genetics, environmental conditions, age of birds, stress, egg collection and handling, and packaging and transport. Eggshell quality, however, is primarily related to management and nutrition, not genetics or other factors. It is becoming a bigger issue as the length of the laying period has extended because, as hens get older, shell quality drops.

"The information in the genetics companies' management guides is for direction and information only, as each egg producer's production goals and conditions can vary", says Vitor Arantes, Global Technical Services Manager and Global Nutritionist, Hy-Line International. He advises listening to your birds. For example, "diets should be aligned with the bird's bodyweight development, rather than the age of birds and following feeding phases according to pre-planned timings for feed changes," he noted.

Below are some of the nutritional factors impacting eggshell quality that producers should keep top of mind.

Early development and pre-starter diets

"Bodyweight at 6-12 weeks of age is key, but to achieve this goal, bodyweight up to 5 weeks of age is a MUST, stressed," Dr. Arantes. "This critical period is an investment, so don't be shy. Poor management in the first 5 weeks will delay production, increase mortality, and prevent the achievement of peak production targets. In turn, it will affect egg quality. Therefore, we must provide proper diets as soon as possible," he said.

As shown below, chicks hatch with relatively underdeveloped internal organs and systems. During the first 5 weeks of age, the digestive tract and the immune system undergo much of their development. The development of the intestine is crucial for nutrient absorption and will determine a hen's future production efficiency. Strong intestinal development will also strengthen the immune system and reduce the possibility of future enteric diseases and improve the response to vaccinations.

Multi-phasic body weight development during rearing and the start of lay

Pre-starter diets support the chicks' transition from being fed by the yolk sac and are relatively high in energy, protein, and the vitamins and minerals required for growth and development. The chicks' limited digestive capacity post-hatch demands easily digestible raw materials. A crumble containing high-quality, functional ingredients provides a good nutritional start in life. The use of feed additives, such as enzymes to improve digestibility, and synbiotics to aid in the early development of a microbial population and to prevent the intestinal colonization of pathogens, known as competitive exclusion, should be considered.

Teaching hens how to eat – preparing for the pre-peak phase

The objective is to develop sufficient feed intake capacity for the period start of lay, by feeding a developer diet from 10-16 weeks of age. This is a diluted diet with high levels of insoluble fiber to develop feed intake capacity (crop and gizzard).

"You can train pullets to eat by taking advantage of their natural feeding behavior," commented Dr. Arantes "Because birds consume most of their feed before lights go off, the main feed distribution (60% of the daily ration) should be in the late afternoon, about 2-3 hours before 'light off'. In the morning, birds will be hungry and finish the feed, including fine particles. Emptying feeders helps to prevent selective eating and will increase the uniformity of the flock. In the middle of the day, there should be no feed in feeders for 60-90 minutes," he noted.

Don't neglect the pre-lay phase

Start feeding a pre-lay diet when most pullets show reddening of the combs, which is a sign of sexual maturity. Feed for a maximum of 10–14 days before the point of lay. This is important to increase medullary bone calcium reserves. Large particle calcium should be introduced in this phase. Do not feed pre-lay later than the first egg as it contains insufficient calcium to support egg production.

There can be a negative impact on feed consumption from the sudden increase in dietary calcium levels from 1% to above 4% at the start of lay. Field experience indicates that the use of pre-lay diets helps as a smooth transition between the developer (low calcium and nutrient density) and the peaking diet. Correct feed formulation and matching diet density with consumption will minimize the impact of reduced calcification of bone over the laying cycle and extend the persistency of shell quality. It also helps to avoid the often-reduced appetite/daily feed intake during early production.

The following are suggested for pre-layer feed:

- 1.25 to 1.40% P
- 2.5% Ca (50% coarse limestone)
- 900-1,100g per hen total
- Never before 15 weeks of age
- Never after 2% hen day (HD) egg production

Understand your limestone

Calcium particle size is important for eggshell quality. Fine calcium carbonate particles pass through the gastrointestinal tract in 2-3 hours, whereas particles above 2mm are retained in the gizzard and will slowly solubilize, delaying the calcium assimilation. Eggshell formation takes 12 to 14 hours and occurs mainly during the night period. Providing a high amount of large calcium particle size before the night, when birds are sleeping, will help laying hens to produce a strong eggshell.

The ratio of coarse to fine calcium particles will increase with bird age as below. Changing the particle size ensures that more calcium will be available at night from the diet instead of from the bone.

Calcium particle size recommendations

Particle size	Starter, Grower, Developer	Pre-Lay	Weeks 17-37	Weeks 38-48	Weeks 49-62	Weeks 63+
Fine (<2mm)	100%	50%	40%	35%	30%	25%
Coarse (2-4mm)	–	50%	60%	55%	70%	75%

The solubility of limestone may differ according to the source. Calcium with high solubility will not be stored for a long time in the gizzard, negating the particle size effect. Dietary calcium levels may need to be adjusted based on the solubility of your limestone. The in vitro solubility of your limestone source can easily be checked on the farm, with a simple technique using hydrochloric acid. The target is to recover 3-6% of the supplemented limestone.

Water

It’s impossible to have good eggshell quality if you don’t have good water intake and good quality water. For example, excessive salt levels in drinking water can cause persistent damage to shell quality.

Conclusion: invest in the rearing phase

Good nutrition and management practices are key to good shell quality. The rearing period is a key developmental time for future success during the laying period – it is an investment phase.

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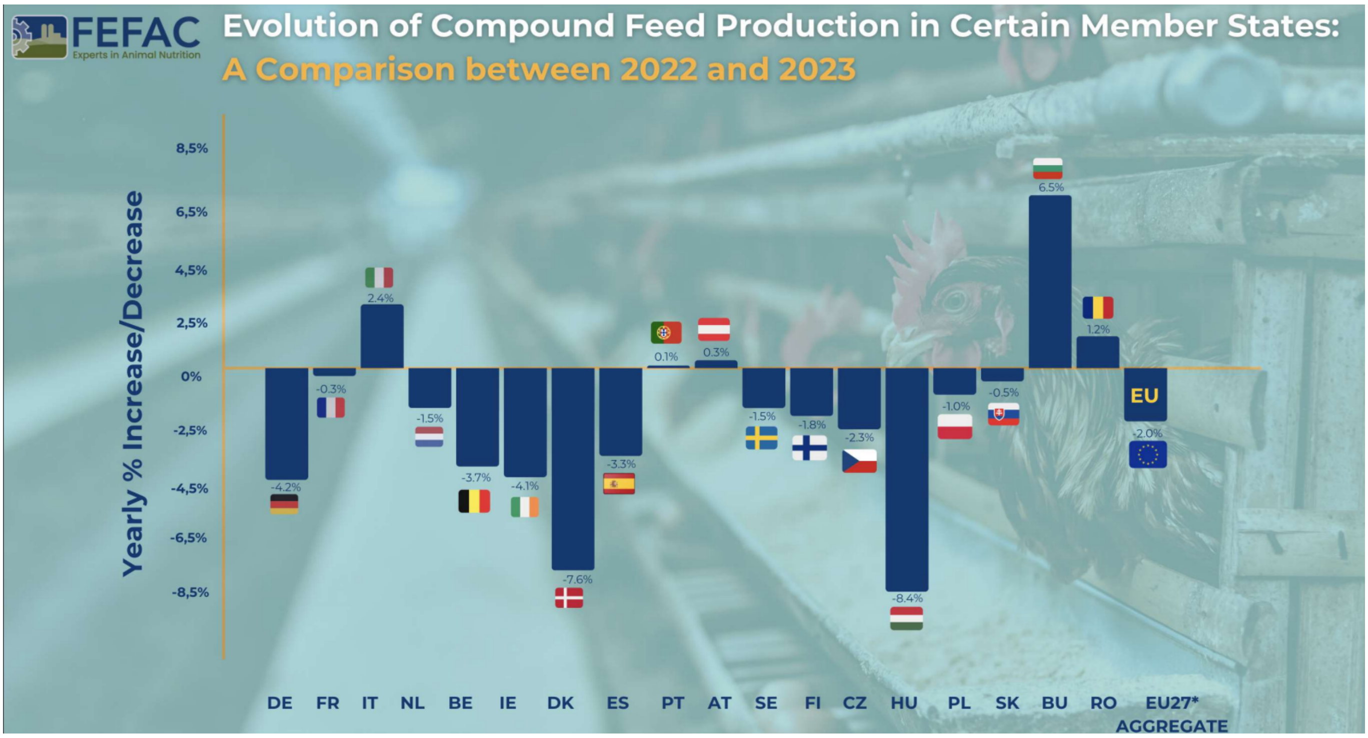
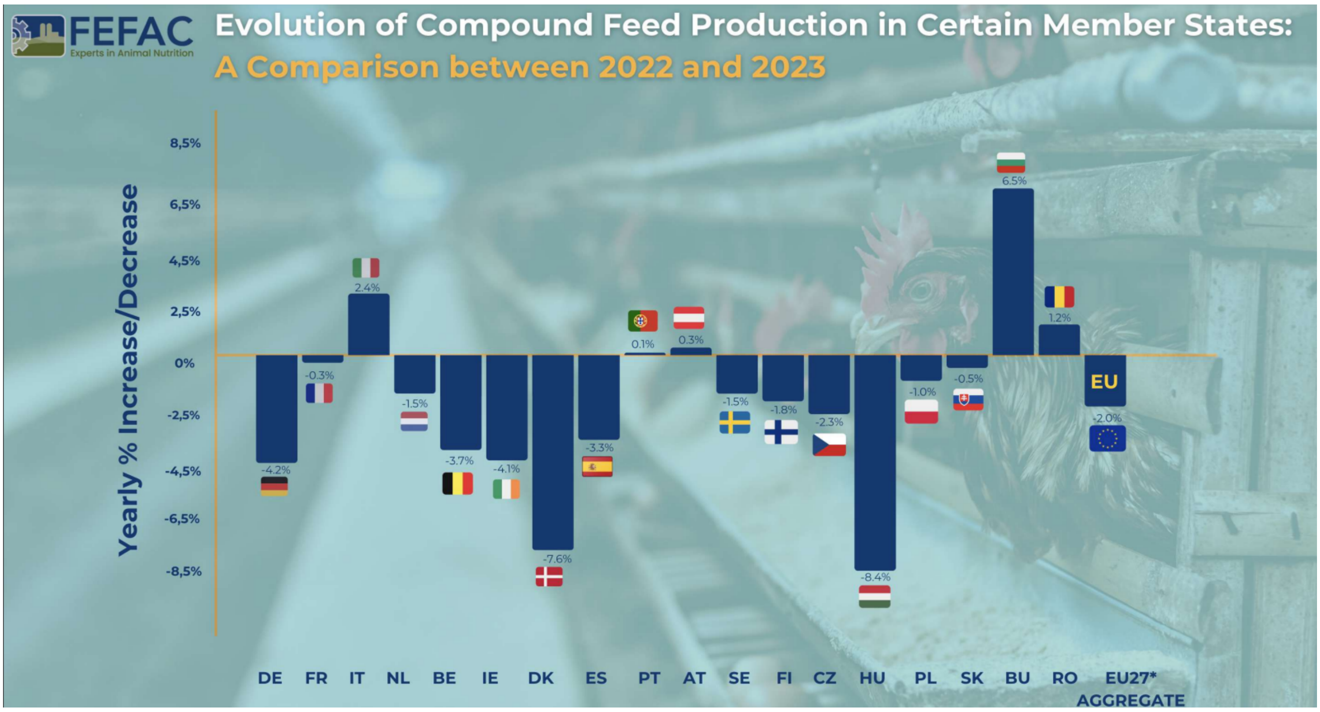
EW Nutrition’s Poultry Academy took place in Jakarta and Manila in early September 2023. Vitor Arantes, Global Technical Services Manager and Global Nutritionist, Hy-Line International, was a distinguished guest speaker in this event.

FEFAC: Quick Overview of 2023 EU Compound Feed Production





Total Production 2023: 144.3 million metric tons for farmed animals

Change from 2022: 2% decrease

Factors Influencing Decrease

Political and Market Pressures: Addressing crises and the shift towards sustainable feed.

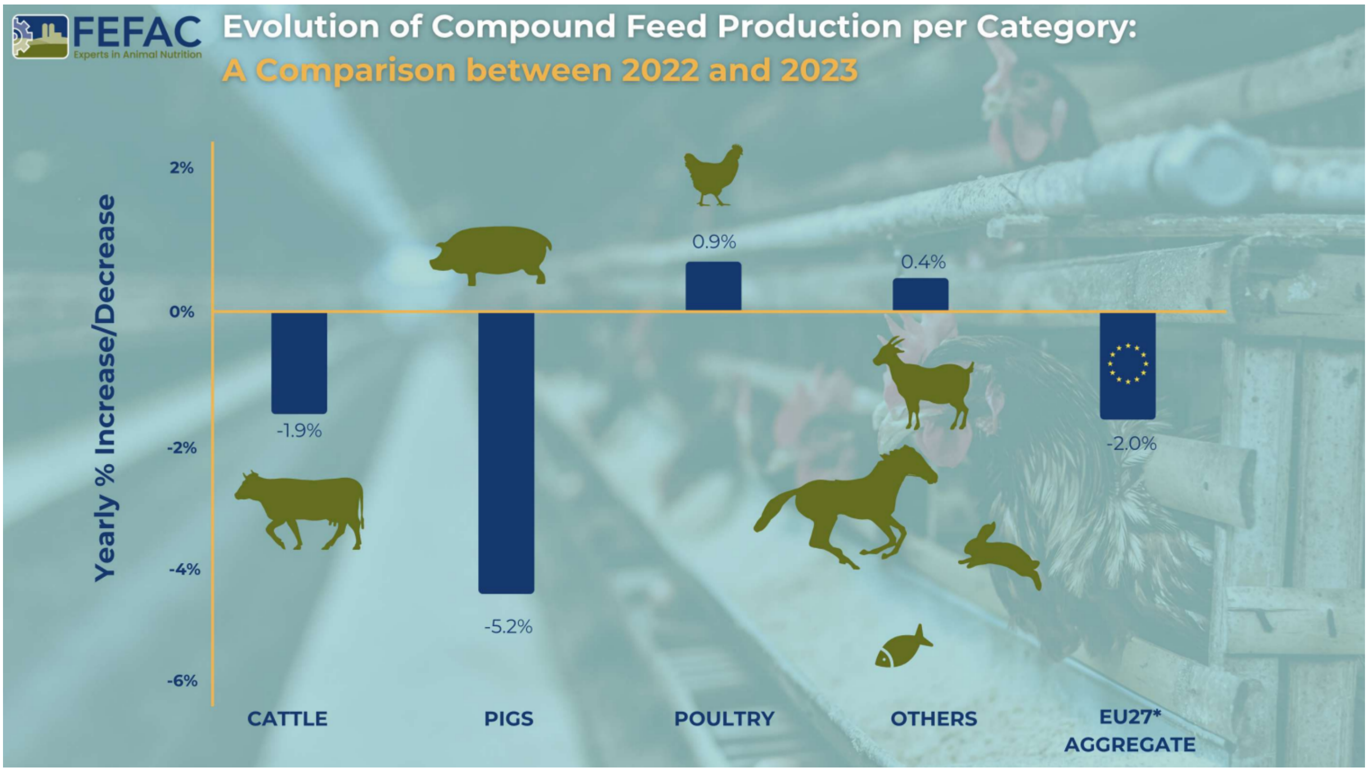
Climate and Diseases: Effects of droughts, floods, Avian Influenza (AI), and African Swine Fever (ASF) on raw material supply and animal production.

National Policies: Initiatives for greenhouse gas and nitrate emission reduction.

Consumer Trends: Food price inflation impacting demand.

Production Variability: Different trends across EU Member States, with notable decreases in countries like Germany, Ireland, Denmark, and Hungary, and slight increases in Austria, Bulgaria, Italy, and Romania.

Sector-Specific Trends



By Species

Pig Feed: Major decline of nearly 2.5 million tons. Key challenges included:

- Loss of export markets, particularly in Asia
- Negative media impact in Germany
- Significant production drop in Denmark (-13.6%) and Spain (loss of 800,000 metric tons)
- Italy’s ongoing struggle with ASF

Poultry Feed: Increase by 0.9 million tons, yet still 700,000 metric tons below 2021 levels. Challenges included declines in Hungary and Czechia due to reduced broiler production.

Cattle Feed: Decrease of 0.8 million tons from 2022.

2024 key factors

- Animal disease
- Economic instability, persistent food price inflation
- Weather irregularities
- Continued imports of poultry meat from Ukraine
- “Green and animal welfare” policies affecting local production

Summary

The EU's compound feed production in 2023 faced numerous challenges, leading to an overall decrease. The pig feed sector was most severely hit, while poultry feed showed some recovery. The influence of environmental, economic, and policy factors played a significant role in shaping these trends. Despite the price of feed cereals falling back to the levels seen before Russia's invasion of Ukraine, these challenges will continue to be felt in 2024.

Source: FEFAC

Optimizing DOC quality, part 1: The breeder perspective

Conference report

In the Poultry Academy held by EW Nutrition in the fall of last year, **Judy Robberts**, Technical Service Manager, Aviagen, explained that the success of a breeder flock depends on producing good quality hatching eggs with high hatchability and delivering first quality chicks. With this in mind, we have to ask two essential questions: What impact does the breeder farm have on chick quality? And What are the most overlooked areas for breeders?

Nest box hygiene

Nest box hygiene is key to good quality hatching eggs. Shortly after egg deposition, the eggshell is moist, and the cuticle is not yet an effective protection. In addition, during this period the egg is cooling down from the hen’s body temperature (41°C) to house temperature. Due to this process of cooling down, the content of the egg contracts and a vacuum is created in the egg. In compensation, air enters and forms the air cell. Together with this air, bacteria can easily penetrate the egg. For this reason, it is very important that only hatching eggs are used which have been laid in a clean nest.

Maintaining a hygienic nest environment with routine cleaning of the nest mat or frequently replacing the bedding material will reduce the risk of bacterial contamination.

Clean nests and nesting equipment are essential to avoiding contamination.

Egg collection and pick-up

schedule

Collect nest eggs a minimum of 4 times a day, more frequently in hot weather, as eggs cannot cool down sufficiently in the house to interrupt embryonic development. Adjust the exact timing so that no more than 30% (any more will increase the incidence of cracked eggs) of the eggs fall in any one collection. When determining collection times, it is important to remember:

- The majority of eggs will be laid in the morning, and collection intervals should be managed accordingly.
- Eggs left in the nest or on belts longer than recommended will have an increased incidence of being cracked or soiled.
- Transition points on belts need to be smooth so eggs don’t pile up and bump into each other.
- Never leave eggs overnight in the nests or belts.
- Eggs left in conventional nests are subject to toe pecks or soiling from other hens.
- Floor eggs (eggs that were laid outside of the breeder flock’s next boxes) should be collected more often than nest eggs.

It is not advisable to collect eggs in cardboard egg trays/flats, as the fiber material absorbs egg heat, and it takes longer for them to cool down. Because the fiber trays are porous, they can also harbor unwanted organisms/bacteria/fungi and attract vermin.

Ideally hatching eggs should weigh a minimum of 50 g from a flock at least 22 weeks of age. Smaller eggs from younger flocks may be used, however, chick size and early livability will not be optimum. Remember that a chick will yield approximately 68% of the egg size. Therefore, a small egg will produce a small chick.

Egg cleanliness

Always wash hands after collecting floor eggs and before each collection of nest eggs. Floor eggs should not be placed in the nest box – even if they appear clean. Washing floor and dirty eggs removes the eggs protective coating. Always remember, a washed egg is still a dirty egg, but a clean egg is one that was never dirty.

Eggs should be treated with chemical-based antimicrobials, as scraping, rubbing, or washing the eggshell will damage the cuticle and remove the physical and antimicrobial barrier. Since the eggshell permeability increases after 24 hours and makes the eggs more susceptible to bacterial invasion, eggs should be sanitized as soon as possible. The most popular method is fogging as it is safe, the fog reaches all the eggs and the eggs do not get wet.

Floor eggs are not hatching eggs

The hatchery cannot fix mistakes from the breeder farm. Therefore, it is NOT recommended to set floor eggs – eggs that were laid outside of the breeder flock's next boxes. Floor eggs have a higher bacterial load than nest eggs and consequently lower hatchability. They are also potential 'bangers, or exploders' and can cross-contaminate other eggs, especially in the same incubator.

Selection of floor eggs must be done at the farm, so that a dirty egg never enters the hatchery. Where strictly necessary, set floor or dirty eggs only if the disadvantages of setting these eggs are fully understood and accepted by the hatchery. If floor eggs are used for hatching, they should be clearly marked and stored separately from the nest eggs so that the hatchery can manage the contamination risk appropriately.

Floor eggs have a significantly higher risk of microbial contamination that will reduce hatch and chick quality.

Egg hygiene – bacterial contamination

Egg condition	Total Bacteria (cm^2)
Newly laid	300
Cooled clean egg	3,000
"Clean" floor egg	30,000
Dirty egg	300,000

Monitor the number of floor eggs and adjust management practices to minimize them. Floor eggs are a problem that should be tackled at the breeder level, with good breeder management and suitable housing equipment. If levels of floor eggs exceed 2-3% across the life of the flock, there is a problem. Floor eggs will be much higher at the start of production, but by peak production should be down to 1-2%.

Cracked eggs

Eggs with cracks are more likely to become infected and have low hatchability and poor chick quality.

Influence of eggshell crack types on hatchability and chick quality

Treatment	Egg weight at transfer (g)	Weight loss (%)	Fertility (%)	Hatchability (%)	Chick weight (g)	Chick uniformity (%)
Normal	62.0[a]	11.4[c]	97.8[a]	83.9[a]	48.9[a]	82.6

Star cracks	55.6[b]	20.7[b]	89.4[b]	49.4[b]	48.2[a]	70.3
Hairline cracks	53.1[c]	24.0[a]	83.3[c]	30.0[c]	45.6[b]	70.2

Khabisi *et al*., 2011 [a-c] Means within a column without a common superscript differ significantly ($p \leq 0.05$)

Do not set cracked eggs. Record the number of eggs with cracks, and if the frequency is unsatisfactory, investigate and eliminate possible causes.

On-farm egg storage rooms

Don't forget that storage starts from the time of laying, not the time of receival at the hatchery.

Eggs need to be cooled below 24°C (threshold temperature or physiological zero) as soon as possible to stop cellular growth of the embryo, until the egg is set at the hatchery. This minimizes embryo mortality, maximizes hatchability and helps to ensure chick quality. Eggs should be stored within 4 hours after collection.

On breeder farms, eggs are usually stored until being transported to the hatchery. The storage duration depends on the egg room capacity, supply of hatching eggs, hatchery capacity, and demand for day-old chicks. Don't forget that storage starts from the time of laying, not the time of receival at the hatchery.

If the farm has an environmentally controlled egg storage room, eggs can be collected by the hatchery at least twice a week. If the farm has no dedicated egg storage room, eggs must be transported to the hatchery daily. Uncontrolled fluctuations in egg storage temperatures will cause stop-start growth of the germinal disc, which will reduce hatchability.

The temperature of the farm egg storage room should higher than the egg transport truck and the egg transport truck temperature should be higher than the hatchery egg storage room. This consistent decrease in temperature is to prevent condensation (also referred to as sweating) on the eggs. Condensation on the eggshell impairs the natural mechanisms of defense and provide an ideal environment for bacteria grow, penetrate the shell, and contaminate the egg. Condensation on eggs is more common in hot and humid climates common throughout Asia.

Egg storage rooms are important, yet they are frequently overlooked. Areas to consider include:

- Consistent temperature 24/7 (insulation will minimize variation),
- Temperature alarm system – set for a maximum temperature of 21°C and a minimum of 16-18 °C,
- Temperature and humidity sensor placement – don't place in a direct line of temperature or humidity sources as this will lead to false readings,
- Do not place sensors against walls,
- Sensor accuracy (loggers are recommended),
- Fans to evenly distribute air,
- Do not place eggs directly against the wall or on the floor in the storage room to maximize air circulation and to ensure uniform conditions, and
- Avoid direct air flow onto eggs from fans, room coolers and/or humidifiers, as this can increase moisture loss and cause temperature variation throughout the room.

The farm is the starting point to ensure chick quality. Attention to detail and hygiene throughout the whole process is critical. Through monitoring and auditing, areas with deficiencies can be identified and corrected to continue producing high quality hatching eggs.

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On breeder farms, eggs are usually stored until being transported to the hatchery. The storage duration depends on the egg room capacity, supply of hatching eggs, hatchery capacity, and demand for day-old chicks. Don’t forget that storage starts from the time of laying, not the time of receival at the hatchery.

If the farm has an environmentally controlled egg storage room, eggs can be collected by the hatchery at least twice a week. If the farm has no dedicated egg storage room, eggs must be transported to the hatchery daily. Uncontrolled fluctuations in egg storage temperatures will cause stop-start growth of the germinal disc, which will reduce hatchability.

The temperature of the farm egg storage room should higher than the egg transport truck and the egg transport truck temperature should be higher than the hatchery egg storage room. This consistent decrease in temperature is to prevent condensation (also referred to as sweating) on the eggs. Condensation on the eggshell impairs the natural mechanisms of defense and provide an ideal environment for bacteria grow, penetrate the shell, and contaminate the egg. Condensation on eggs is more common in hot and humid climates common throughout Asia.

Egg storage rooms are important, yet they are frequently overlooked. Areas to consider include:

- Consistent temperature 24/7 (insulation will minimize variation),
- Temperature alarm system – set for a maximum temperature of 21°C and a minimum of 16-18 °C,
- Temperature and humidity sensor placement – don’t place in a direct line of temperature or humidity sources as this will lead to false readings,
- Do not place sensors against walls,
- Sensor accuracy (loggers are recommended),
- Fans to evenly distribute air,
- Do not place eggs directly against the wall or on the floor in the storage room to maximize air circulation and to ensure uniform conditions, and
- Avoid direct air flow onto eggs from fans, room coolers and/or humidifiers, as this can increase moisture loss and cause temperature variation throughout the room.

The farm is the starting point to ensure chick quality. Attention to detail and hygiene throughout the whole process is critical. Through monitoring and auditing, areas with deficiencies can be identified and corrected to continue producing high quality hatching eggs.

Optimizing DOC quality, part 2: The hatchery perspective

Conference report

At EW Nutrition's Poultry Academy in the fall of last year, **Judy Robberts**, Technical Service Manager, Aviagen discussed the impact of the hatchery on chick quality. The transportation and storage of hatching eggs, preventative maintenance, and day-old chick transport all play an essential role. If mismanaged, these areas can negate the benefits of money spent and improvements made at the breeder farm or even in the hatchery itself.

Egg transport from breeder farm to hatchery

The transportation of hatching eggs from the breeder farm to the hatchery is critical: clean and disinfect the truck prior to use, to prevent pathogen spread, and only use a truck that is dedicated to transport hatching eggs. Always transport eggs small end down to avoid loose air cells.

The temperature of the farm egg storage room should higher than the egg transport truck. This decrease in temperature is to prevent condensation (also referred to as sweating) on the eggs. Condensation on the eggshell impairs the natural mechanisms of defense and provide an ideal environment for bacteria grow, penetrate the shell, and contaminate the egg. Condensation on eggs is more common in hot and humid climates common throughout Asia. Even when on-farm egg storage and truck temperatures are equal, sweating can still occur during loading and unloading, especially on warm and humid days. In such a case, a higher on-farm storage temperature of 23°C instead of the generally recommended 18-20°C can be considered.

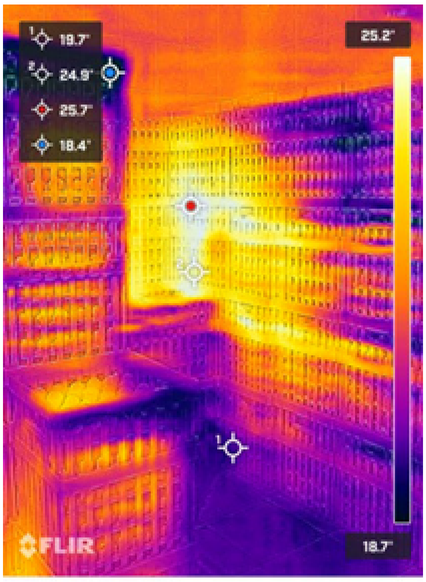
Avoid sudden temperature changes. Use temperature loggers during transport to record any temperature fluctuations. Take internal egg temperatures at different locations within each batch received at the hatchery, to check temperature conditions during transport. The relative humidity of the truck should be set at 65-70%.

Egg storage at the hatchery

Don't forget that storage starts from the time of laying, not the time of receival at the hatchery. Egg storage rooms are important, yet they are frequently overlooked. Areas to consider include:

- Consistent temperature 24/7 (insulation and fans will minimize variation),
- Avoid condensation,
- Do not place eggs directly against the wall or on the floor in the storage room, to maximize air circulation and to ensure uniform conditions,
- Alarm systems – set for a maximum temperature of 21°C and a minimum of 16-18°C,
- Sensor accuracy (loggers are recommended), and
- Sensor placement – don't place in a direct line of temperature or humidity sources as this will lead to false readings. Similarly, allow for air circulation, do not place sensors against walls.

Temperature and storage time



"The holding temperature should be based on storage time," advised Ms Robberts. Eggs which are set within 4 days of lay don't need to be kept at a temperature below 20°C; in this case 21–22°C is regarded as optimal. This relatively high temperature promotes the thinning of the albumen, which improves the gas exchange during early incubation. On the other hand, it is low enough to maintain the vitality of the embryo. Best hatches result from eggs 3–7 days of age. Storage for longer than 7 days will require cooler temperatures to help reduce the loss of hatch due to embryo cell death and decline in internal egg quality. If the storage period is less than 7 days a storage temperature of 16-18°C is advised and if the storage period is longer, a temperature of 10-12°C is mostly recommended. The eggs of young breeder flocks are better suited for prolonged storage periods than eggs of older breeder flocks, as albumen quality in eggs of younger breeder flocks is higher.

Differences in temperature will result in the eggs reaching incubation temperature at different times and, therefore, hatching at different times, increasing the hatch window.

Relative humidity

The egg storage room should have a relative humidity of 70-80% to prevent egg dehydration and to maintain internal egg quality. The humidity should be a fine mist, so the eggs do not get wet. Humidifiers should be maintained and cleaned regularly. Dirty humidifiers can be a significant source of bacteria and lead to egg contamination. Follow the same guidelines for trolley placement, spacing, and air circulation in the hatching storage room as the farm egg storage room. Likewise, the same recommendations apply for thermometer monitoring and placement.

Don’t forget the maintenance

Maintenance is often reactive, not preventative – things are only fixed when they break down. This can compromise hatchability and chick quality. A few things to consider when setting up a maintenance plan are:

- Have a dedicated person responsible for maintenance reporting to the hatchery manager,
- Produce a list of all the equipment to be maintained including frequencies,
- Keep records on all performed maintenance,
- Maintenance includes calibration of equipment,
- Keep track of spare parts on hand, and
- Include the building structure and ancillary equipment in the program.

Day-old chick transport

Transport cannot improve the quality of the day-old chick, but it can certainly harm the chick’s welfare, growth, development and performance.

If chicks are transported outside their thermoneutral zone (32-35°C) they will start using up the nutrients from the yolk sac at a much faster rate to maintain their core temperature (40-41°C) . A core temperature above 41°C post-hatch will lead to panting resulting to water loss with the risk of dehydration and below 39.5°C will lead to reduced activity and low feed consumption. Adjust the number of chicks per box if optimal temperature inside the chick boxes cannot be achieved due to limitations in transport equipment.

Optimizing transport conditions for day-old chicks from hatchery to farm for is beneficial for subsequent performance.

Conclusion

The modern hatchery is a major investment, so it just makes sense to pay attention to detail to maintain hatching egg quality and produce high-quality chicks. Factors such as egg storage conditions, play a significant role in achieving maximum hatchability. Through monitoring and auditing, areas with deficiencies can be identified and corrected to continue producing high quality hatching eggs. The transport of day–old chicks from should ensure that the birds arrive at the farm in the same condition in which they left the hatchery.

Getting broilers off to a good start: House preparation

Conference report

At the recent EW Nutrition Poultry Academy, **Judy Robberts**, Technical Service Manager, Aviagen discussed the management of broilers for growth & production efficiency. She noted that the first 7 days is the most critical period in the life of a broiler chicken. “In this period chicks are the most efficient at converting feed to weight, however, its digestive and immune systems are still immature, so you want to get your chicks off to the best possible start,” she said.

“Seven-day weights are a key KPI of the success of brooder management – chicks should weigh at least 4 times their initial body weight. Also, each 1 gram of bodyweight at 7-days of age is equivalent to 10 grams at 35-days.The goal of management during the first week is to ensure that chicks consume enough feed and water because chick weight at 7 days of age is strongly correlated to final body weight at slaughter,” noted Ms. Roberts.

To ensure chicks got off to the best start, her presentation included 6 essential factors for house preparation and brooder set-up for the successful placement of chicks:

Planning

Planning should start well before chicks arrive on farm. The expected delivery date, time and number of chicks should be established with the supplier well in advance of chick placement. It is impossible to do the best possible chick placement if you do not know what you are going to receive, at least several days in advance. For example, the age and vaccination status of the donor flock. This will ensure that the appropriate brooding set-up is in place and that the chicks can be unloaded and placed as quickly as possible.

Chick placements should be planned so that chicks from different aged donor flocks can be brooded separately. Chicks from young donor flocks will achieve target body weights more easily if kept separate until the time of grading at 28 days of age.

Also, is the capacity of the equipment, such as feeders, drinkers, water pressure etc., capable of meeting the needs of the number of chicks to be placed? Do you have necessary supplies, such as chick paper, on hand?

Equipment test

- After cleaning and disinfection is completed, check that all water, feed, heat, ventilation, and lighting equipment is fully functioning and properly, adjusted for the needs of day-old chicks before the chicks arrive. Heaters should be checked and serviced before starting pre-heating.

Litter and pre-heating

Chicks do not have the ability to regulate body temperature for the first 5 days and are not able to fully control their body temperature until about 14 days of age. They quickly become chilled if placed on cold litter, which hinders their search for feed and water. In case of floor rearing, bring in the litter after preheating the floor for at least 24 hours (commencing from when the floor is dry and depending on heater type and capacity, season and building insulation) before chicks arrive to allow the litter to reach 28-30°C. Floor temperature is more important than air temperature because chicks are in contact with litter via bare feet. If the floor is cold, chicks lose body heat to the floor through their feet and through their body when they sit down. Measure temperatures throughout the brooding area with a digital on the litter surface and approximately 2 cm above the litter, as this is where the chicks will be placed.

Litter should be evenly spread, and at least 5cm deep to provide adequate insulation from cold house floors. Air temperature will rise rapidly after the heat is turned on, but it takes much longer to thoroughly warm the mass of litter on the floor. Litter should have good moisture absorption and water holding capacity. Uneven litter can restrict access to feed and water and may lead to a loss in uniformity.

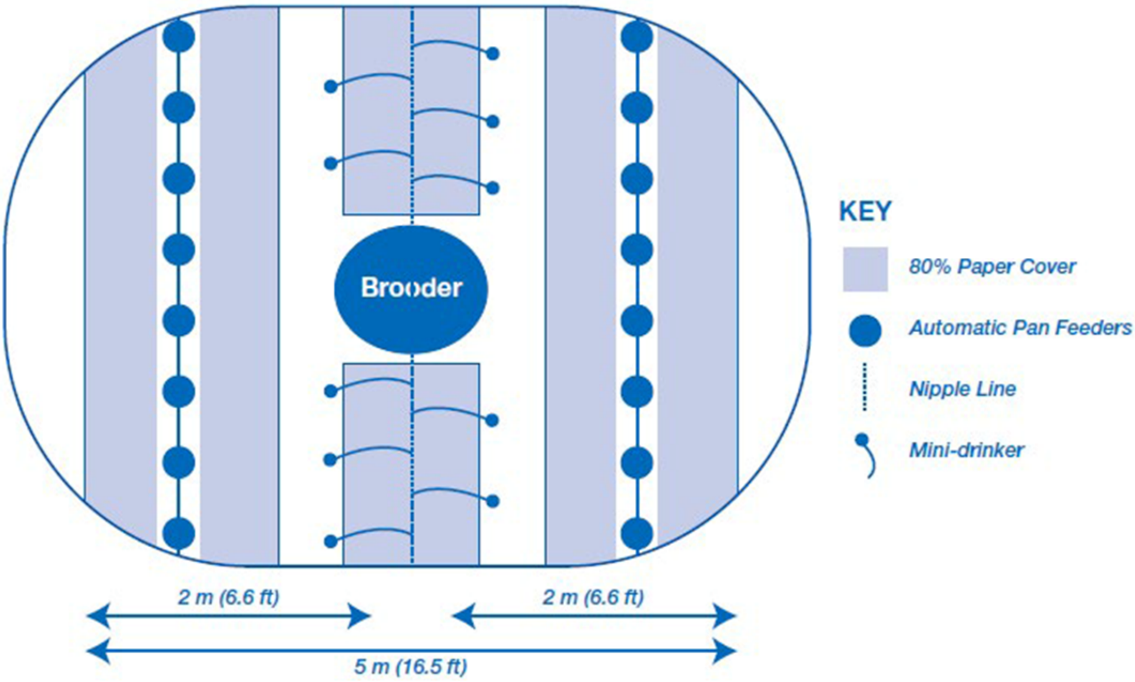
Preheating can ensure that the litter is properly dried prior to placement to reduce bacterial growth and ammonia production.

Brooding area set-up

Allow an initial chick stocking density of 40-50 chicks/m^2, do not give excess of floor space. The size of the brooding area will also be determined by the output of the heat source.

Light intensity should be30-40 lux, uniform and continuous for the first 48 hours to ensure chicks find food and water.

The use of a brooder guard is recommended for the first 5-7 days to confine chicks to near the heat source. The guard should be about 50 cm high. If made of solid material, such as cardboard, it can also protect the chicks from drafts. Brooders should be 2 m away from brooder edge.



Example of spot brooder layout

Temporary guards to confine chicks

Minimum ventilation set-up

Ventilation distributes heat evenly throughout the house and maintains optimum air quality in the brooding area. Minimum ventilation should begin with house preheating 24-48 hours prior to placement to remove waste gases and excess moisture.

Target that 24 hours before chicks arrive to achieve 28-30ºC air and floor temperature, and relative humidity should be 60-70% when chicks enter the house to prevent dehydration. Humidity exceeding 70% limits the amount of evaporation, causing wet litter and excessive litter caking.

Young birds are very susceptible to drafts, so air speed in the brooding area (at chick level) should be less than 0.15m/second.

- Allow enough air exchange with a minimum ventilation rate at placement of 0.09m^3/hour. Use a 5 minute fan cycle (with a thermostat override) – 30-45 seconds on.
- Make sure temperature and humidity sensors are placed correctly. For spot brooding, 2 meters away from the edge of each brooder, and for whole-house brooding at the center and two additional sensors at the end wall of the house. Sensors should not in contact with birds and out of direct lines with heating system.

Feed and water supply

Starter feed should be ordered to ensure delivery 1-2 days before chick placement.

Once the chicks arrive, they need to begin drinking and eating as soon as possible. Poor quality crumble or pellets will result in reduced feed intake and poor performance. Feed distribution should minimize the physical deterioration in crumble and pellets. The amount of fine particles (<1 mm) in sieved crumbles or mini-pellet should be below 10%.

Turn on the mechanical feeding system and ensure all pans or chain feeders are filled. Automatic pan feeders should be buried into the litter, so chicks can easily access them.

Spread a thin layer of starter feed onto chick paper to cover at least 80% of the paper area and fill any feeder trays 1-2 hours prior to chick arrival to prevent feed and water from becoming too hot. At least 20-30% of the total feed offered should be placed on paper. Paper should be positioned alongside the automated feed and drinking systems to aid in the transition from temporary to automated systems. Replenish feed on paper in small amounts given frequently. At placement, chicks should be placed directly onto paper, so that feed is immediately found.

If using paper, the feed area should cover at least 80% of the brooding area (avoid drinkers and feeders)

Papered Feed Area

Never place supplemental feed or water directly under or near brooders. Ensure that supplementary feed never runs empty and always remains fresh.

Water is the most immediate need when chicks arrive at the house because they can easily dehydrate during hatching, processing, and transport to the farm. Chicks must have unlimited access to clean and fresh water (18-21°C). Cold water will chill the chicks.

- Flush drinkers 2-3 times to remove any remaining disinfectant. Remove dust and litter from cups. Adjust drinker line height to bird’s eye level. Ensure the placement of supplementary drinkers and feeders allows easy access for chicks and workers.

At placement, lower nipple drinkers to the chick’s eye level with sufficient water pressure to produce a droplet of water suspended from the nipple without dripping

Droplet Drinking

Ms. Robberts concluded that “if house preparation is done properly then chicks are ready for a good start.” If there is any delay, it is always better that the chicks waits inside the truck (if its environmentally controlled) rather than getting cold waiting in the house. Chicks cannot become cold or heat stressed!”

Low Crude Protein Diets in Poultry: Understanding the

Consequences

Conference report

The concept of feeding poultry, specifically broilers and layers, with reduced crude protein (CP) diets is gaining traction among nutritionists. The economic implications of balancing amino acids currently dictate dietary CP levels. At the recent EW Nutrition Poultry Academy in Jakarta, Indonesia, Dr. Steve Leeson, Professor Emeritus at the University of Guelph, Canada, raised a crucial question: “What does ‘low CP’ really mean?” He states that it typically means a reduction of maximum 2-3% relative to current CP levels.

Low CP diets generally involve a decrease in soybean meal, compensated by higher grain content. This change increases dietary starch and decreases dietary lipid levels. To meet nutritional needs, these diets also include higher amounts of crystalline (synthetic) amino acids.

Dr. Leeson outlined the advantages and disadvantages of low CP diets. **Positives** include improved gut health due to reduced proteolytic bacteria, less environmental pollution, lower water intake (improving litter quality), improved sustainability indices, increased dietary net energy, and better performance during heat stress. **Negatives** encompass issues like lower pellet quality, altered dietary electrolyte balance, higher diet costs, reduced growth rate and feed efficiency, and increased abdominal fat deposition. There are also questions about the presumed complete utilization of crystalline amino acids, which can be as high as 25kg/MT in these diets.

Challenges with Low CP Diets

- **Protein vs. Amino Acids**: Diets are typically formulated based on digestible amino acid content, though minimum CP levels remain common, to avoid reduced performance: Dr. Leeson noted that broiler diets with less than 19% CP in starter and 15% in finisher phases, and layer diets below 13% CP, often fail to deliver adequate performance, regardless of digestibly amino acid supply.
- **Utilization of Free Amino Acids**: The crystalline amino acids are immediately absorbable in the small intestine, contrasting with protein-bound amino acids that are absorbed as di- and tri-peptides. Amino acids absorption dynamics and endogenous loss of amino acids are affected by (high) levels of crystalline amino acids.
- **Non-Essential Amino Acids**: The impact of reduced CP on animal performance might be related to the lower levels of presumed non-essential amino acids, e.g. glycine and serine. This is an area for further exploration.
- **Energy Level Considerations**: Dr. Leeson suggests maintaining specific ratios of digestible lysine to apparent metabolizable energy in broilers at different growth stages. The heat increment of CP is an essential factor, as it reduces net energy efficiency, possibly requiring an adjustment in amino acid to metabolizable energy ratios as poultry diets are not based on net energy values.
- **Gut Health**: Lower CP levels can reduce the flow of undigested protein into the hindgut, reducing the risk of necrotic enteritis, and the production of harmful metabolites, like biogenic amines.
- **Role of Proteases**: Protease use can lead to a further 2-4% reduction in dietary CP, with the response depending on the inherent protein digestibility of the diets.
- **Impacts on Pellet Quality**: Due to the binding properties of protein, each 1% reduction in CP typically results in a 2% decrease in pellet durability (index).
- **Electrolyte Balance**: Reduced CP can significantly lower dietary electrolyte balance, which has to be considered in feed formulation. Amongst the nutrients contributing to DEB value, Sodium and Potassium appear to be the most influential minerals to consider.

Conclusion

Dr. Leeson anticipates that low CP diets will become increasingly relevant. They have the potential to reduce environmental pollution and dependence on soybean meal, despite current challenges in reducing feed costs.

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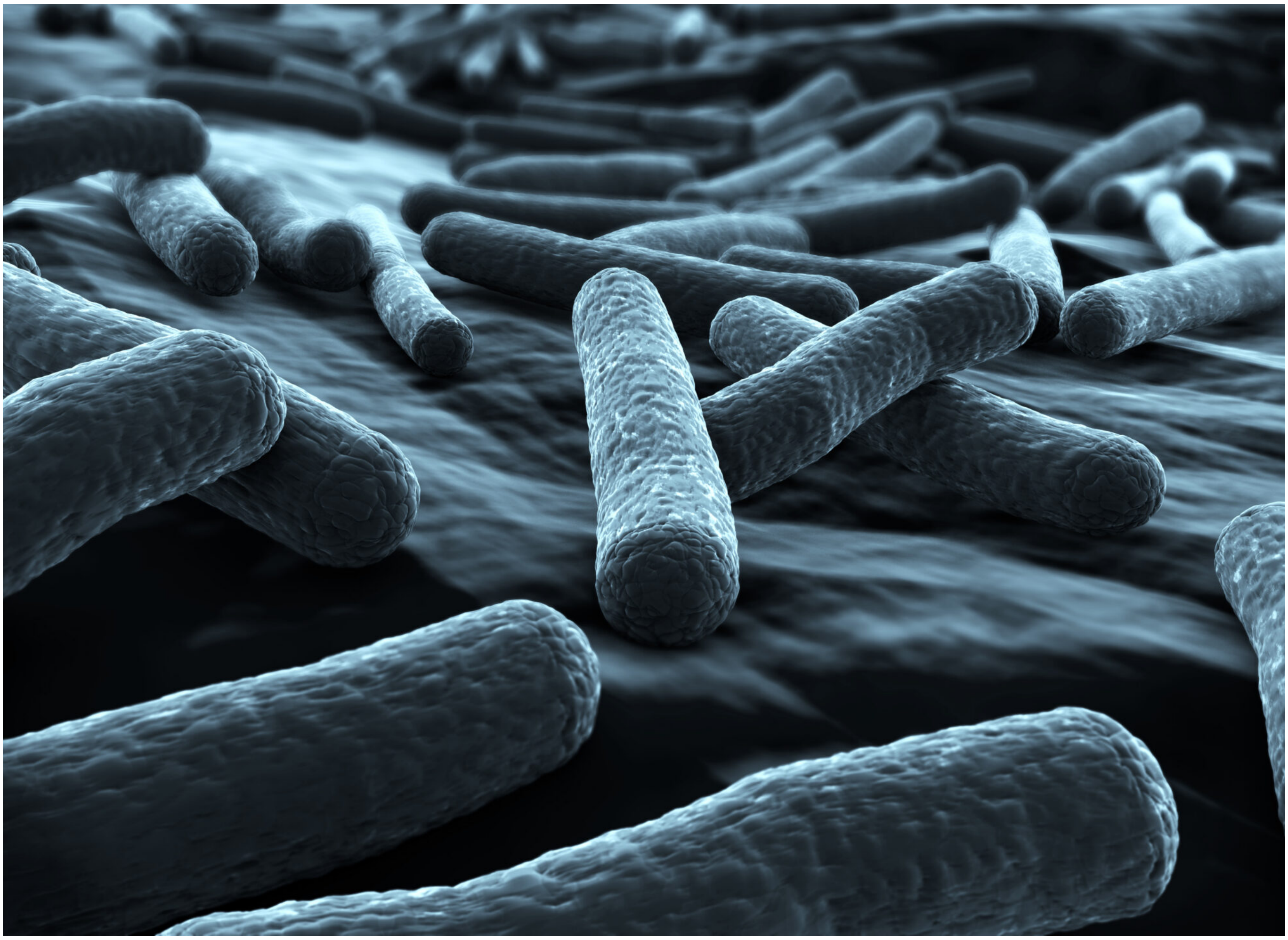
EW Nutrition's Poultry Academy, featuring Dr. Leeson, took place in Jakarta and Manila in early September 2023. With nearly 50 years of industry experience, Dr. Leeson has made significant contributions to poultry nutrition and management, evidenced by his numerous awards and over 400 published papers.

Endotoxins in 250 words



Dr Inge Heinzl, EW Nutrition

Endotoxins are… toxic, of course. The part "endo" in their name means that they are part of the bacterial cell, or, to specify it, they are part of the outer membrane of Gram-negative bacteria such as *E. coli*, *Salmonella*, *Shigella*, *Klebsiella*, and *Pseudomonas*.

When do they occur?

Always. Endotoxins are released with the lysis of bacteria, e.g., at the end of their life cycle, due to the effective immune defense of the host or treatments. The other possibility is bacterial growth as the membrane gets restructured and the endotoxins (or lipopolysaccharides -LPS-) are liberated.

What is the problem?

The "normal" occurrence (animals and humans always have Gram-negative bacteria in their gut) does not matter, because gut cells do not have receptors to recognize them as a danger in their apical side. However, when the barrier function is compromised, they pass into the bloodstream.

The liver still detoxifies small amounts. The problem comes with higher amounts of endotoxins in the bloodstream. Then, they provoke a strong immune reaction, feed intake drops, and nutritional resources are shifted from growth and production to immunity. These performance drops affect the profitability of the farmer.

What can be done?

Use broad-spectrum toxin binders that

- contain clay minerals showing high affinity and selectivity against endotoxins
- contain yeast cell walls, which, in addition to their binding capacity, support the immune response through macrophage activation and are involved in modulating microflora and bacterial load from the intestine
- provide adequate liver protection.

Housing and management strategies to mitigate heat stress in layers

Dr Daniel Valbuena, *Global Manager of Technical Services, Hy-Line International –* *Conference Report*

Heat stress is one of the major environmental stressors in the poultry industry, especially in regions with high temperatures and high humidity. In EW Nutrition's Poultry Academy in September, the topic was approached in a comprehensive and practical presentation.

A layer's normal body temperature is about 40° C. Hens are comfortable with an ambient temperature 18° C to 24° C. When that temperature gets above 32° C, the more serious consequences of heat stress occur.

To mitigate the negative effects of heat stress on bird welfare, production, and profitability, essential best practices include those listed below.

Ventilation

Airflow at the birds' level is key to removing bird heat. Naturally-ventilated barns are particularly at risk of heat stress. Increase the movement of air in open houses with stir fans. Ensure a minimum velocity of 1.8–2 meters/second in the bird areas.

Clean and ensure function of fan louvers. Fan belts should be tightened or changed to avoid slipping or breaking during periods of high temperature. Poorly maintained fans will operate at 50% reduced efficiency.

Air inlets must be adequate to supply the airflow needed to ventilate the house during warm weather. Inadequate inlet space will throttle down the fans and decrease airflow. Inlets should be kept clean and free of anything that might restrict the flow of incoming air. Use baffle boards to direct incoming air onto the birds. Thermostats should be checked for accuracy. An auxiliary power system must be in place in case of a power outage during hot weather.

In addition to running fans throughout the day when it’s hot, fans should run overnight and early morning to bring in cooler air. Air inlets should be adjusted to achieve uniform airflow throughout the building.

In houses equipped with evaporative cooling systems, the pads should be cleaned or replaced when they become clogged. Water flow over the pads should be uniform with no dry areas. Air will flow preferentially through dry areas since there is less resistance. Clean spider webs and dust from window screens frequently to improve ventilation inside the house.

Fans increase air velocity within the house and create a cooling effect.

Foggers

Fogging or misting is effective at low humidity (<60% relative humidity). Excess moisture in the air from using foggers or misters at high humidity can worsen heat stress conditions.

Foggers or misters need to be checked routinely and should run about 2 minutes out of every 10 if the humidity is low, however, run times can be adjusted based on house temperature and humidity. Fogging the inlet air in negative pressure ventilation systems has a good cooling effect.

Fogging systems should have water filters (to keep nozzles from clogging) and have a positive shutoff to prevent dripping causing wet litter.

Foggers should mist, not irrigate, and not operate if the humidity exceeds 60%.

Roof design and cooling

Insulated roofs (R28 is recommended) reduce the radiation and conduction of solar heat through the roof to the interior of the house. Reflective roofing materials or light-coloured materials are recommended.

Ensure to provide ridge vents at roof level to allow hot air to exit so that fresh air may enter the house through side openings. The roof should have an overhang (minimum 60 cm) to reduce direct and indirect sunlight getting into the house.

Thatching can provide cost-effective insulation, but may need to be replaced every few years, and is difficult to clean, and may harbor vermin.

Use of shade netting (left) or thatching material such as palm fronds, paddy straw, corn stalks, sugarcane tops (right) to reduce solar heating of the roof.

Using roof sprinklers during times of extremely high temperature can remove heat from the roof and cool the inside of the house.

Curtains

Adjustable, porous side-wall curtains can be used control the flow of air into the house, and protect birds from direct, hot winds. Water dripping onto side curtains can reduce the house temperature.

Porous window shades block direct sunlight from entering the house but allow air to pass through.

Bird handling

Management practices that require bird handling, such as beak trimming, transfer, and vaccinations, should be done in the early morning hours, or in the evening, when it’s not so hot. Heat-stressed birds have decreased immune function and may not respond as well to vaccination. Alternatively, if birds are panting, they may breathe in too much of a spray vaccine or ingest too much of a water-administered vaccine. In both situations, birds may exhibit signs of the disease that the vaccines are intended to prevent.

Stocking density

It’s critical not to overstock cages. If stocking density is high, the radiant heat between the birds accumulates and the temperature increases. Birds need to be able to spread their wings to increase airflow around their bodies. Caged birds are more susceptible to heat stress because they are unable to seek a cooler place and there is less opportunity for conductive heat loss in cages. The temperature within a cage can be much higher than the measured air temperature in the walkway. Increased air velocity within the cages increases the convective heat loss and removes trapped air between birds.

Manure management

Manure allowed to accumulate reduces ventilation in cages. Remove manure from the house before the hot season, if practical. Heat produced during the decomposition of manure contributes to the heat load in the house. The presence of large amounts of manure in shallow pit houses or under cage batteries restricts the movement of air.

Be prepared and anticipate

- The key to minimizing the effects of heat stress is to be prepared and anticipate periods of high environmental temperatures, and implementing appropriate management measures *prior* to the rise in temperatures. Implement cooling systems, such as evaporative cooling pads, misting systems, or fans. Provide natural or artificial shading within the layer house to reduce direct sunlight exposure. Shade structures, curtains, or baffles can help protect the hens from excessive heat.
- Farm personnel should be trained to recognize and respond to heat stress promptly. You should also have an emergency plan in place for extreme heat events.