

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.

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.

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 nest 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 nest 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 receipt 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 receipt 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 be 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 provides an ideal environment for bacteria to 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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Improve health and productivity in breeders with phytomolecules



By **Dr. Inge Heinzl**, Editor, and **Technical Team**, EW Nutrition

Careful management of the breeders is a must to get their best reproductive efficiency. In today's hatching egg production, factors such as stress, inflammation, body weight, and altered mating behavior lead to decreased performance, meaning fewer hatchable eggs and, therefore, fewer day-old chicks per hen ([Grandhay, 2020](#)). The use of antibiotics to increase performance in farm animals is no longer allowed in many countries, and, since it may lead to the development of resistance, it is also not recommended. So, also in breeders, alternatives are requested to maintain animal health, welfare, and a high level of performance.

Optimal gut health is the cornerstone for breeder performance

As the organ responsible for digestion of the incoming feed, the absorption of nutrients, and the defense of the organism against pathogens or toxins, a healthy gut is a pre-condition for optimal performance ([Shini and Bryden, 2021](#)). A healthy gut, according to [Bailey \(2018\)](#), has optimally developed gut tissues, a well-functioning gut immune system, and well-balanced gut microbiota. It shows efficient functionality in terms of digestion and absorption and protects the organism against harmful agents.

The gut directly or indirectly provides the elements for egg production

Efficient feed digestion and absorption of nutrients are essential for the breeder hen to obtain the “material” for maintenance, growth, and egg production. Gut health is crucial since dysbacteriosis and diarrhea, characteristics of gut health challenges, increase dirty eggs, creating favorable conditions for pathogens to enter the egg and infect the embryo.

Egg yolks consist of water (70%), proteins (10%), and lipids (20%). The yolk lipids are lipoproteins rich in triglycerides, built up in the liver and transported to the ovary. Cholesterol carried via lipoproteins to the egg yolk is also built up there, thus showing the importance of the liver in egg production. The gut plays a crucial role in protecting the liver from damage, constituting a barrier against harmful pathogens and toxins, potentially passing into the bloodstream and reaching this vital organ.

Phytomolecules support performance in different ways

Phytomolecules, are an excellent tool to support gut health and animal performance. Phytomolecules are plant-derived secondary metabolites that exert insect-attracting or defensive functions in the plant. They are used in their natural but also nature-identical forms in humans and animals to exert their digestive, immune-modulating, antimicrobial effects.

Phytomolecules support gut health by balancing the gut microbiome

Diverse examples can be found in the scientific literature, where phytomolecules improve the gut microbiome, resulting in better performance of layer and breeder hens. This support happens in two ways:

1. Promoting beneficial bacteria

[Rabelo-Ruiz and co-workers \(2021\)](#), asserted that adding garlic and onion extracts to the diet of layers led to more eggs with a bigger size, accompanied by an increase in Lactococci in the ileum and Lactobacilli in the cecum. Another example is provided by [Park et al. \(2016\)](#). When supplementing the diet of layers with a fermented phytogenic feed additive, egg production and weight raised with increasing dosage of the additive, and a higher number of Lactobacilli could be observed in the cecum.

Phytomolecules can promote the growth of certain beneficial bacteria and therefore act like prebiotics. As these changes took place in the lower gut, they assumed an improved digestibility of the feed.

2. Lowering pathogenic bacteria

In the study by Park et al. (2016) and in an in vitro study by [Ghazanfari et al. \(2019\)](#), *E. coli* in

the cecum was reduced.

According to [Burt \(2007b\)](#), several essential oils / phytomolecules, amongst them, carvacrol, thymol, eugenol, and cinnamaldehyde, are effective against pathogens such as *Listeria*, *Salmonella*, *E. coli*, *Shigella*, and *Staphylococcus*. The hydrophobic essential oils can partition the lipids of the cell membranes. The resulting permeability of the membrane enables the leakage of cell content.

3. Changing virulence factors

Another mode of action is the change of virulence factors. Carvacrol, e.g., is known to decrease the motility of *Campylobacter jejuni* ([Van Alphen et al., 2012](#)); oregano and thyme oil reduced the motility of *E. coli* by inhibiting the synthesis of flagellin ([Burt, 2007a](#)). [Vidanarachchi et al. \(2005\)](#) mentioned that the hydrophobicity of microbes increases when some plant extracts are present, affecting their virulence characteristics. Also, the inhibition of defense measures such as efflux pumps in Gram-negative bacteria has been researched ([Savoia, 2012](#)).

Phytomolecules support gut health by improving digestion

For many years, phytomolecules have been studied and known for their digestive characteristics. In poultry and other animals, they influence feed digestion in two main ways.

1. Stimulating enzyme secretion

[Platel and Srinivasan \(2004\)](#) described different spices promoting not only the salivary flow, gastric juice and bile secretion but also the stimulation of the activity of enzymes such as pancreatic lipase, amylase, and proteases in rats. [Hashemipour et al. \(2013\)](#) saw the same effect in broilers supplemented with carvacrol and thymol in the diet. Research has also concluded on a higher nutrient digestibility: [Hernandez et al. \(2004\)](#) and [Basmacioğlu Malayoğlu, 2010](#) noticed that supplementing plant extracts or essential oils improved apparent whole-tract and ileal digestibility of different nutrients.).

2. Maintaining gut integrity and enlarging the digestion area

An intact gut with a large area for digestion guarantees optimal utilization of nutrients. Different researchers found that adding plant extracts or essential oils ([Khalaji et al., 2011](#); [Ghazanfari et al., 2015](#); [Chowdhury et al., 2018](#)) promotes intestinal gut morphology, reflected in higher villi and deeper crypts, which might lead to higher nutrient absorption.

Concerning gut integrity, thymol and carvacrol showed protecting effects and mitigated gut lesions in broilers challenged with *C. perfringens* ([Du et al., 2016](#)). Probably, the lower pathogenic pressure due to the antimicrobial activity of phytochemical substances leads to minor damage to the gut wall and, in the end, to better absorption of the nutrients.

Phytomolecules mitigate the effects of stress

Environmental stress in breeders may decrease performance: the heat-stress-induced disruption of the tight junctions often leads to higher gut permeability, poor nutrient absorption, and higher electrolyte and water secretion ([Abdelli, 2021](#)). [Sahin et al. \(2010\)](#) achieved a linear improvement in egg production in quails when applying two doses of green tea catechin.

Cold-stressed layers also reacted positively to supplementation of oregano essential oil, improving egg production compared to a non-supplemented control ([Migliorini, 2019](#)).

Positive influence of phytochemicals results in higher performance

As described, phytochemicals improve gut health and support the animal in multiple ways, allowing better utilization of resources for growth and production. Literature provides many articles showing the promoting effects of these substances on the performance of layers or breeders, some of them summarized in Table 1.

Table 1: Benefits of phytochemicals in layers and breeders

Compounds	Reference
Main effects: Improved egg weight, egg mass, and higher hen-day-egg production	
Oregano & thyme	Abdel-Wareth (2013)
Main effects: Higher fertility and hatchability	
Oregano, rosemary & thyme	Nadia (2008)
Main effects: Higher egg production, egg mass, better FCR	
Thyme, oregano, rosemary & curcuma	Nadia (2008)
Effects: improved laying performance	
Thyme	Bölükbaşı (2007)
Mint	Abdel-Wareth and Lohakare, 2014; Abdel-Wareth and Lohakare, 2020;
Menta & Geranium	Dilawar, 2021
Peppermint & thyme	Akbari et al., 2016
Black cumin	Abou-Elkhair et al., 2020; Khan et al., 2013
Fennel	Abou-Elkhair et al., 2020
Hot pepper	Abou-Elkhair et al., 2020; Al-Harhi, 2004
Alliaceae	Rabelo-Ruiz et al., 2021; Abad, 2020
Green tea	Al Harhi, 2004
Tea polyphenols	Wang, 2018
Tea-tree oil	Puvaca, 2020

In-feed and in-water phytochemicals-based products show efficacy

Much of the research done with phytochemicals focuses on essential oils (with variable inclusions of the active compounds or on single plant extracts). EW Nutrition is a research-driven company proposing phytochemical-based solutions for the animal production industry. These products combine selected, synergistically acting phytochemicals to achieve optimal results.

EW Nutrition has tested the combined use of

- a microencapsulated blend of phytomolecules (Activo) for the feed and designed to maintain a good gut-health status during the whole life-cycle of the breeders, and
- Activo Liquid, a liquid combination of phytomolecules and organic acids, which is conveniently applied on the farm via the waterline.

1. Trial documents phytomolecules positively influencing microflora

A trial conducted at the University of Central Queensland (Australia) showed that phytomolecules enhance beneficial bacteria such as *Lactobacilli* and, on the other hand, repress harmful bacteria such as *Clostridium perfringens*.

For the trial, caecal microbiota of layers was used. They were grown with and without Activo Liquid in vitro, and the changes in microbiota were monitored.

Result: The in vitro study clearly shows that Activo Liquid increases the number of *Lactobacilli* and decreases *Clostridia* and *Enterococcus sp.*

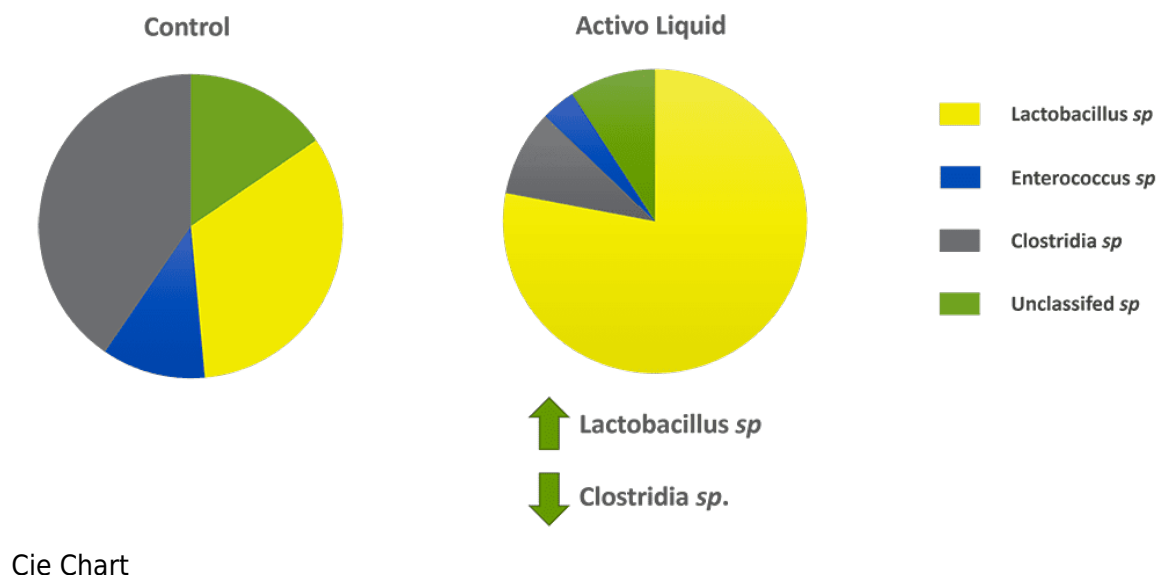


Figure 1: Shifting intestinal balance with phytomolecules

2. Three field trials with Activo Liquid showed an increased laying rate in breeders

Many operations started testing phytomolecules in a farm-application-based program to reaffirm the gut health-improving activity of phytomolecules in broiler breeder performance. Especially the flexibility of assisting animals through the water for drinking during stress periods makes phytomolecules an optimal tool to support gut health.

Two broiler breeder farms in Thailand (TH1 and TH2) and one grandparent farm in India (IN) are good examples of the effectiveness of phytomolecules. On each farm, the birds were always divided into two groups. Besides the standard management, feed, and water, one group got 200 ml Activo Liquid per 1,000 L of water. The periods when the birds received Activo in the water differed:

TH1 & TH2: 5 days per week, during weeks 24 – 32

IN: 5 days per week, every third week from weeks 18 to 24 and every fourth week from 28 to 36

The trials lasted for 9 weeks (Thailand 1 and 2) and 30 weeks (India).

The results are shown in figure 2. The animals supplemented with Activo Liquid showed an up to 4.4 % higher laying rate and up to three more hatchable eggs per hen housed.

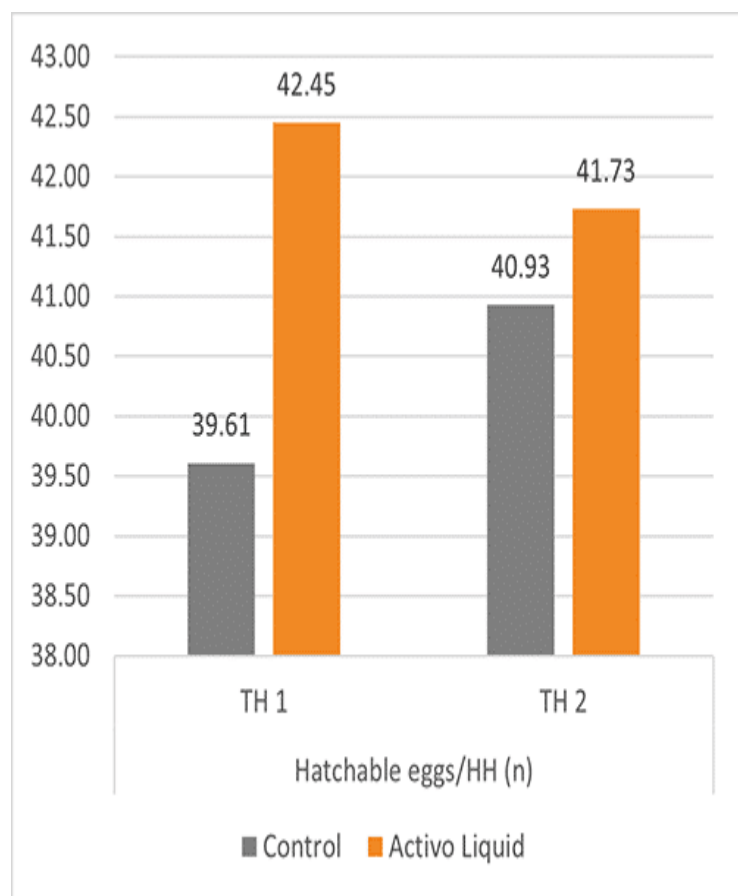
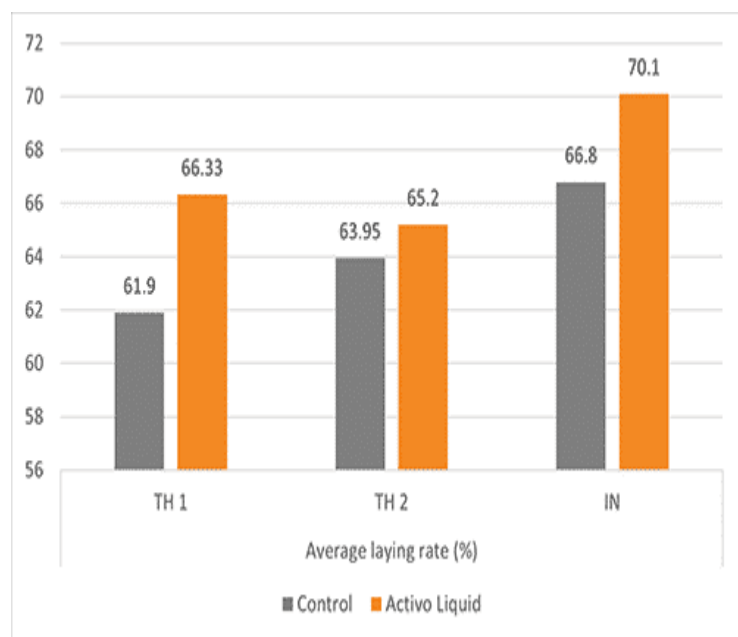


Figure 2+3: Results of three trials conducted In Asia concerning laying rate and hatchable eggs

3. Customers tell about lower breeder mortality and more DOCs due to phytomolecules

The benefits of a tailored phytomolecule program have been demonstrated in several broiler breeder operations worldwide. For example, a combination of the in-feed (Activo) and the in-water solution (Activo Liquid) was tested in the Middle East. For the study, 75,000 23-weeks-old broiler breeders were divided

into groups: 4 houses with the program, and 6 houses served as control (standard feed and water). The program, tailored to customer needs, was designed as follows:

AC+AL group:

- Activo 100 g/ton of feed during the whole trial (weeks 23-41) +
- Activo Liquid 250 ml/1000 L water, four days per week, weeks 23-30.

As a result, the peak and average laying rates were higher for the flocks with the program, and laying persistency was also higher. This allowed for a significant difference of 3 total and 3.5 hatching eggs/hen housed at week 41. In both cases, an increase equivalent to 5 % compared to the control group (figure 4) could be observed.

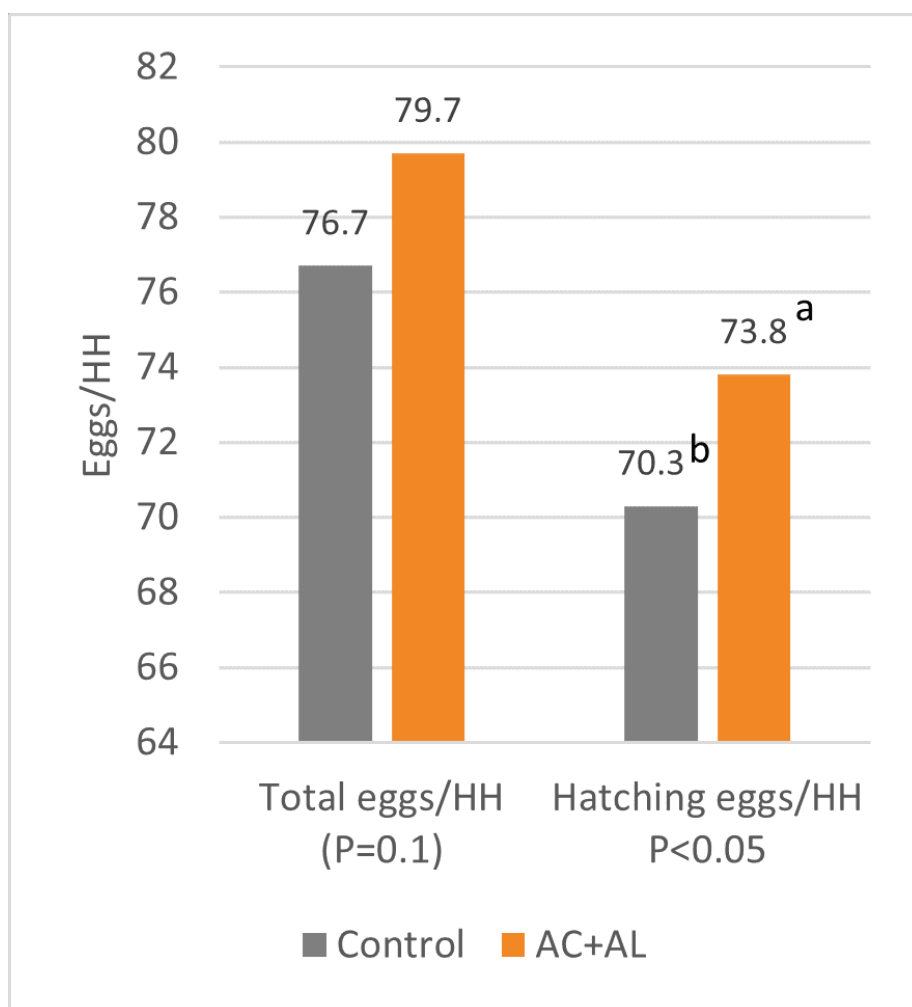


Figure 4: Total eggs and hatching eggs per hen housed

As fertility and hatchability were similar for both groups, the 5 % increase in hatching eggs resulted in a 5 % higher number of day-old chicks per hen housed (figure 5).

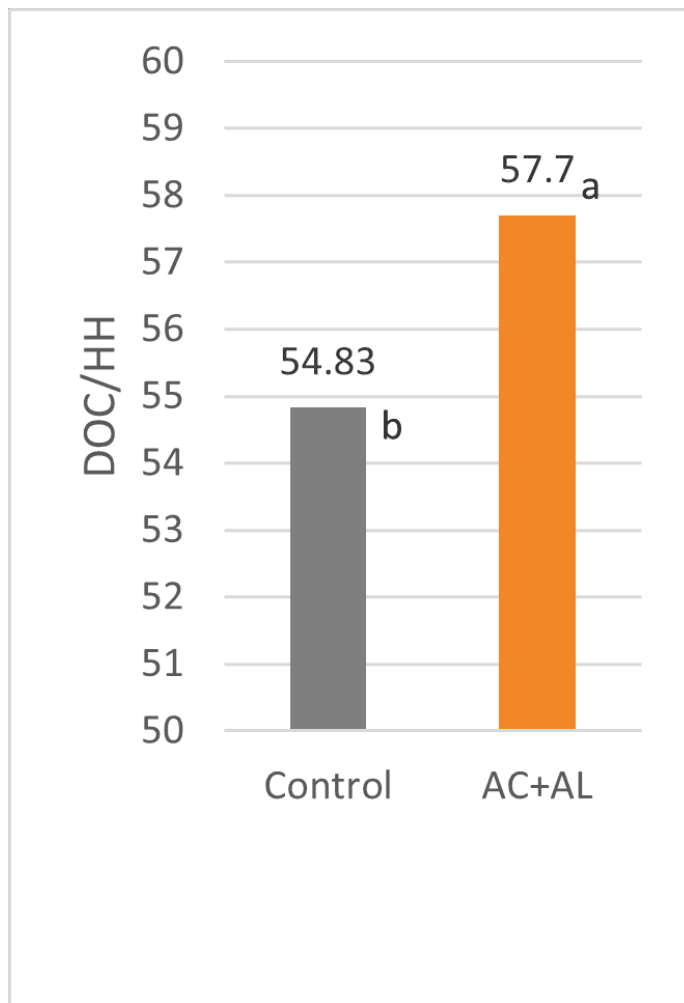


Figure 5: Number of DOSs per hen housed

It must be mentioned that during the trial period, at 28 weeks of age, an NDV outbreak was diagnosed on the farm, which negatively impacted the overall results. However, this impact was reduced in the groups receiving the phytomolecule-based products, which also was reflected in a lower mortality rate (figure 6).

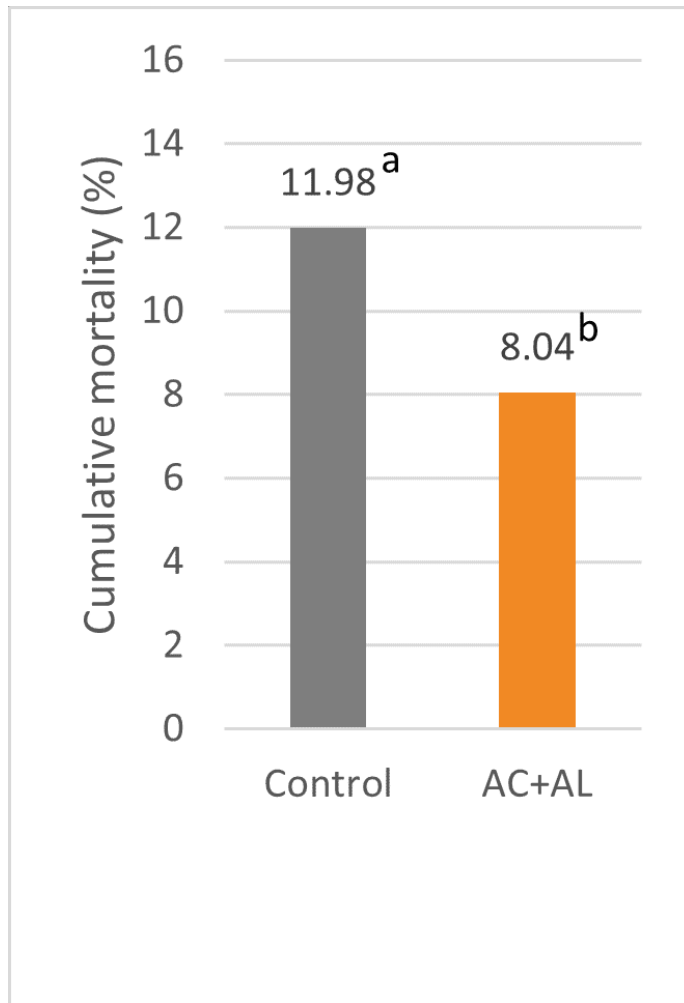
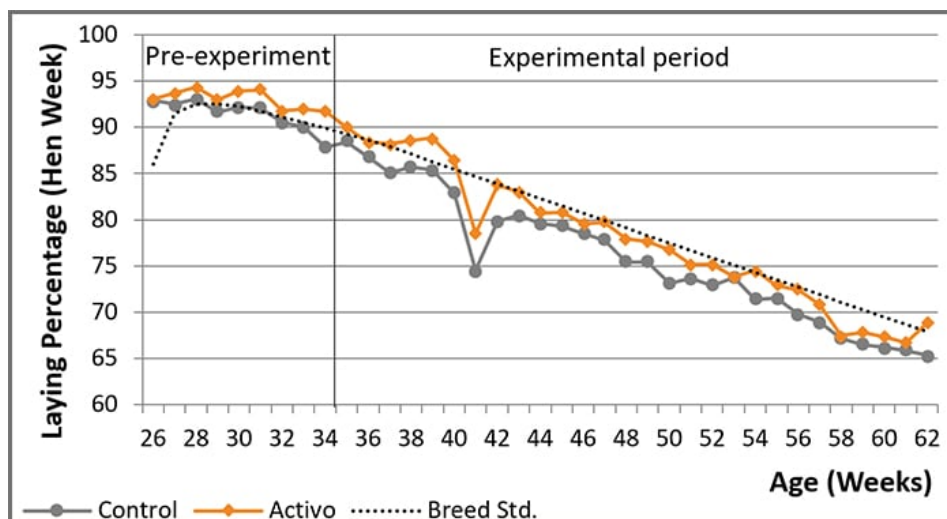


Figure 6: Cumulative mortality rate wk 41

4. Scientific trial shows that Activo can increase post-peak productivity in breeders

When thinking about the use of phytomolecules, most broiler breeder operations would like to consider scientific trial results in this type of animal. For EW Nutrition, it is crucial to accurately evaluate every product that reaches a market. Thus several scientific trials with broiler breeders have been performed. For one of them, Hubbard breeders (JA57 females with 80 M77 males) were divided into 2 treatments, having 5 replicate pens for each. The experiment started after the peak production period, at 34 weeks of age, and ended at week 62. To make the trial fair, the production data of 6 (pre-experimental) weeks was used to allocate the pens for each treatment, resulting in two (statistically) similar groups.

The control group was fed the standard mash diet. For the Activo group, 100g Activo/MT was added to the diet.



With Activo, breeders kept their high productivity after the peak, while the control group showed a steady decline from breed target values. During the experiment, Activo supplemented birds produced 3.6 more eggs than control birds ($P=0.06$) while consuming a similar amount of feed. As a result, a lower feed consumption per egg produced was achieved (169.9 vs. 173.6 g/egg, respectively).

As the dietary treatment did not influence hatchability, the 3.6 extra eggs resulted in 2.9 extra day-old chicks per hen during the post-peak period, showing a positive return.

Phytomolecules as gut health and performance promoters- antibiotics can be reduced!

With their gut health-promoting activity, phytomolecules support breeders to better utilize nutrients. They can be invested for maintenance and the production of hatchable eggs, obtaining good quality day-old chicks.

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Hatchery management in ABR production



By *T.J. Gaydos*

Producing high-quality chicks is critical to the success of any broiler program, but it is even more important in an antibiotic-free (ABF) program. The hatchery is the perfect environment for the incubation of eggs and, consequently, bacteria and mold. This makes hatchery sanitation a very high priority in ABF production systems because of the inability to use antibiotics in the hatchery or later in production.



Chick quality can be divided into two categories:

- microbiologic
- chick vitality

The reality is many of the processes that impact these two categories are often intertwined but can be generally separated into

- sanitation practices
- setting/hatching practices

It is not helpful to set specific objective benchmarks for an individual hatchery without understanding its specific challenges. The hatchery manager must realize that the end product is a healthy, robust chick; therefore, benchmarks and numerical goals for the individual hatchery, breed, and flock age need to be established.

There are a host of measurements that can be performed and data that can be collected; however, it only makes sense to collect only information that will be used to make decisions. It is easy to over-collect and under-utilize data.

Hatchery sanitation

Bacterial contamination

Hatchery sanitation starts at the breeder farm. Eggs are a significant source of contamination in the hatchery; consequently, floor eggs should not be brought to the hatchery. If they must be hatched for egg flow needs, it is essential to at least segregate them from the regular egg flow throughout the process. It is imperative to send a clean egg pack to the hatchery (transport and store the eggs at proper temperatures and humidity). Once the eggs are at the hatchery, the focus is on proper storage, incubation, and hatching.

Monitoring sanitation

The risk of multiplying bacteria in the hatchery is high. Hatchery equipment can be difficult to clean, there are sufficient nutrients to support microbial growth, and the environment is perfect for incubation. Developing a program to monitor the cleanliness of the hatchery is a critical step in managing sanitation. The whole hatchery must be regularly cleaned and disinfected, and the most effort should be spent on chick contact surfaces.

Egg flats must be clean and dry before returning to the breeder farm. Hatcher baskets must be clean and dry before eggs are transferred. The tray wash machine should use a detergent and disinfectant to remove and sanitize the trays (the water temperature should be 140°F). A disinfectant with residual efficacy should be used after the tray wash. Too low of a temperature will encourage bacterial growth, and too high a temperature can damage the baskets.



When using an *in ovo* vaccination system, it is essential to clean and disinfect the machine after every use and prepare it for the next transfer. Chick belts, counters, chick baskets, hatchers, and setters are all areas that can harbor pathogens. Wet areas are also at risk for harboring disease: wet bulb thermometers, humidification equipment, and tray washers. All these areas should be regularly checked for cleanliness by traditional microbiology or rapid ATP testing.

It is important to monitor the hatchery air quality on a regular basis to ensure the level of bacteria and fungi is not too high. This is most effectively accomplished by placing air plates in key locations for air movement such as clean hatchers and setters and their respective halls, and plenums. The areas where vaccines are stored, mixed, and prepared should be surgical suite clean.

Hatching practices

Chick vitality

A high-quality, active chick is one of the keys to program success. The actual profile used to hatch that bird is a mixture of breeder flock profile, hatchery equipment, climate, and experience. When evaluating a hatchery and a hatching program, it is best to start at the endpoint and work backward.

Managing chick comfort in the holding room is vital to set the chicks up for success on the farm. The chicks will tell you if they are too hot or too cold and if they have too much or too little airflow. This is determined by experience and monitoring behavior.

Tracking chick rectal temperatures is a useful way to check comfort. Remember that a small animal can change their body temperature from ideal to hyper- or hypothermic extremely quickly. On average, 103.5°F is a good benchmark for chick internal temperature. Moving backward through the process, evaluate the vaccine spray cabinet to ensure chicks are getting the proper vaccines at the proper rate.

The next critical opportunity to monitor chick vitality is when chicks are being separated from hatch debris.

The volume of chicks passing through the site allows for rapid evaluation of the flock. In this area, it is important to check for open navels, strings, red hocks, green chicks, dirty chicks, and general appearance and behavior.



Hatch debris

The egg should be pipped and broken almost exactly in half. The debris should have minimal meconium, yolk stains, and should not smell bad. Excess meconium is an indication that the hatch window is prolonged, and the chicks spent too much time in the machine before pull.

When eggshells are crushed in one's hand they should break, but the membrane should remain intact. If the membrane also breaks, it is a sign that the chicks were potentially overheated, incubated too long, or humidity was too low.

Chick yield

One of the most useful measures of the setting process is [chick yield](#), which is the weight of the chick at hatch compared to the weight of the egg set. Chicks with a low yield were set with a high temperature or low humidity or were hatched for a long time before being removed from the hatcher. Chicks with a high chick yield are a result of the opposite: low temperature and high humidity incubation or did not spend enough time in the hatcher post-hatch. The ideal chick yield depends on the breed of chicken and the

individual hatchery, but 67-68 % yield is a good benchmark. 

Breakout

Analyzing [hatch debris](#) is a crucial tool for understanding setting and hatching efficiencies. Embryo mortality is variable but tends to follow a consistent pattern. The majority of embryo mortality is early (1-7

days), with little mortality in the middle (8-14 days), and the second increase in embryo mortality occurring from 15-18 days. Results should be recorded, and a standard developed for the hatchery. Deviations from this standard should be investigated.

When aiming to improve the data collection process, focus on building a program that prioritizes the most useful information. Breakouts and chick yields are two of the most meaningful tests to modify the hatching process. Sanitation checks and monitoring of disinfectant levels at critical sanitation steps are valuable to improve hatchery quality. When all the pieces come together, high quality egg pack, sanitation, and excellent hatchery management, the result is a high-quality chick ready to succeed on the farm.

Broiler breeder management in ABF production: 3 essential steps



By *T.J. Gaydos*

Broiler breeders are the basis for the egg supply of an integrated company. All the management details of raising broiler breeders are important and require attention. Raising breeders and managing for persistency of lay, peak, fertility, and egg handling are important for all production systems. These details become more important when managing their progeny without the use of antibiotics.



Management in an ABF system requires extra attention - especially egg handling and sanitation. With the inability to use antibiotics in the progeny, it is critical to not bring additional pathogens into the hatchery on or in dirty eggs. A clean, well-managed egg pack will improve performance and animal welfare and significantly reduce seven-day mortality and the risk of foodborne illness.

1. Cleanliness in the broiler breeder house and egg room

Managing egg cleanliness starts in the broiler breeder house before the first egg is laid. The house needs to be cleaned between flocks; at a minimum, water lines and nest pads should be cleaned and sanitized. The egg handling equipment and egg room should also be cleaned and disinfected. Special attention should be paid to egg contact surfaces and places where water accumulates, such as refrigeration and humidification equipment. If the previous flock had any disease issues, the houses should be thoroughly cleaned and disinfected. Between flocks, pest control is critical to reduce disease pressure: flies, rodents, and darkling beetles should be the focus as they are well-documented transmitters of disease. When adding shavings back to the house, it is important to not overfill the house to ensure there is a step between the scratch and the nest and thus help reduce the amount of litter and feces tracked into the nests.



2. Training the birds

Once new breeders are moved to the house, it is important to train the birds on their location and not let hens learn to sleep in the nests. As hens begin to lay, training them not to lay floor eggs is an essential part of a clean egg pack.

Ensuring there are no dark spots, that any floor eggs are picked up quickly, and the scratch is walked on a regular basis are all important parts of the training to lay in nests. The temptation to set floor eggs is high, especially visibly clean eggs; the best way to eliminate this temptation is to reduce the amount of floor eggs. Visibly clean floor or slat eggs typically contain several logs more bacteria than clean nest eggs. Intestinal health is important to decrease the likelihood of soiled eggs.

High quality feed ingredients should always be used in breeder diets and the electrolyte balance carefully monitored to reduce the risk of flushing.



3. Handling the eggs

The egg is well evolved to prevent contamination of the chick. There are multiple layers of protection: cuticle, shell, outer and inner shell membranes, and albumen. The cuticle and shell must be protected to reduce contamination. When removing minimal visible contamination, it is important to damage as little of the cuticle as possible.

3.1 Removing dirt

Dry contamination should be scraped off with a fingernail or soft plastic scraper. Wet contamination should be removed with a clean paper towel or disinfectant wipe. When removing wet contamination every effort should be made to prevent cross contamination of a larger area of the egg. Eggs should not be buffed clean since this may push dust and bacteria into the pores of the egg, limiting gas exchange and increasing contamination risk.

Any significantly soiled egg should be discarded. It is not advised to wash eggs or wet eggs for disinfection.

Gentle handling of eggs is important to reduce the risk of micro-cracks in the shell, further increasing the risk of bacterial contamination and dehydration.

3.2 Egg temperature and humidity

When packing eggs, fill the buggies from the bottom to the top. This decreases the risk of heating already cooled eggs, potentially reducing embryo viability. If egg packing equipment is used, it is important to clean the machine regularly. Special focus should be paid on the suction cups and rollers since they are in direct contact with the eggs and are very hard to clean.

As eggs cool, a slight vacuum is produced that may draw any liquid on the surface into the egg. Every effort should be made to ensure that eggs do not get wet. If they become wet, it is imperative to allow them to dry before putting them in the cooler. Egg trays and racks should be thoroughly cleaned and disinfected at the hatchery before returning them to the farm. Dirty or wet trays should not be used, they should either be thoroughly cleaned and disinfected on the farm or returned to the hatchery for cleaning.

Managing cooler temperatures is vital for hatchability. Additionally, it is important that eggs are continuously getting cooler to reduce the risk of sweating eggs. The hatchery egg cooler should be 15°C or 59°F, the farm egg cooler 2°C warmer or 17°C, and the egg transport truck in the middle (~16°C). The humidity during storage should be 70-80% RH. Humidification devices are a high risk for microbial contamination; therefore, ensure that they are cleaned and disinfected frequently, and any mist is not directed towards the egg pack.

Conclusion

Appropriate management of the egg supply is key for any poultry company. The need for increased cleaning and disinfection is amplified in an ABF system. Clean and properly handled eggs are a fundamental step to producing high quality chicks.

Eggshell quality: 3 solutions for older laying birds



by **Ruturaj Patil**, Product Manager Phytogenic Liquids, EW Nutrition

Older laying birds are still a valuable asset, as long as they are managed for performance and productivity. Eggshell quality is one of the elements that, without proper management, can quickly deteriorate. It is therefore essential that the egg producer takes into account all the necessary elements for the formation of high-quality eggs.



The eggshell, in a nutshell

The eggshell represents ten percent of the entire egg, by weight^[i]. For instance, a 60-gram egg contains approximately 6 g of shell. Out of this particular shell, approximately 95% is CaCO_3 ^[iii], with a total of 2.3 g of Calcium (Ca).

But where does the calcium in the eggshell come from?

The Ca required for the eggshell is obtained, in variable proportions, directly from the feed or water additives (absorbed from the gut and transported via the blood to the shell gland), or from the bone (resorbed by osteoclasts and the Ca transported to the blood to the shell gland).

Maintaining eggshell quality and bone calcium: Mission Impossible?

Eggshell quality is often negatively correlated to bone strength^[iii], most probably because body calcium is redirected to the shell to the detriment of the bones and the other way around. This impacts the long-term health of the skeleton; however, modern laying hens can maintain shell quality while preserving bone mineralization^[iv].

60 to 75% of shell Ca is derived from the diet on shell-forming days

Approximately 60 to 75% of shell Ca is derived directly from the [diet](#) on shell-forming days^[v]. This means that the greater the proportion of Ca coming directly from the feed or water additives, the better the eggshell quality can be. Therefore, the factors that can improve shell quality will also reduce the need to mobilize bone Ca and can also help to maintain skeletal health.

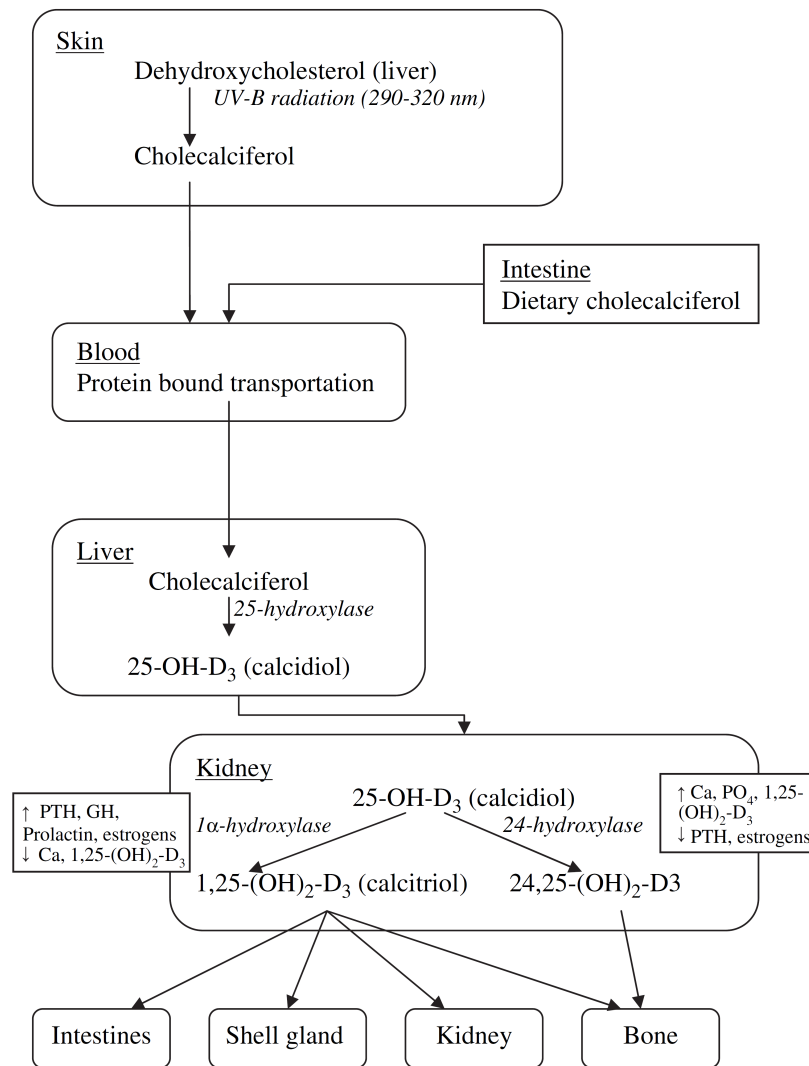
In old laying birds, generally after peak production, the ability to deposit Ca onto the shell remains relatively constant^[vi], so an increase in egg size after peak production will tend to result in reduced shell quality. Dietary requirements for Ca tend to increase and those for phosphorus (P) tend to decrease as hens age.

Also, as hens age, the efficiency of Ca metabolism decreases^[vii]. Increases in dietary Ca and a widening of the Ca:available P ratio are intended to counter this issue. Excess dietary P can also reduce shell quality^[viii].

Because of its importance in Ca and P absorption from the gut, adequate dietary vitamin D activity must also be provided^[ix]. Feeding of the vitamin D metabolite 25-OH vitamin D3 can help to maintain skeletal and shell quality in high-producing laying hens^[x].

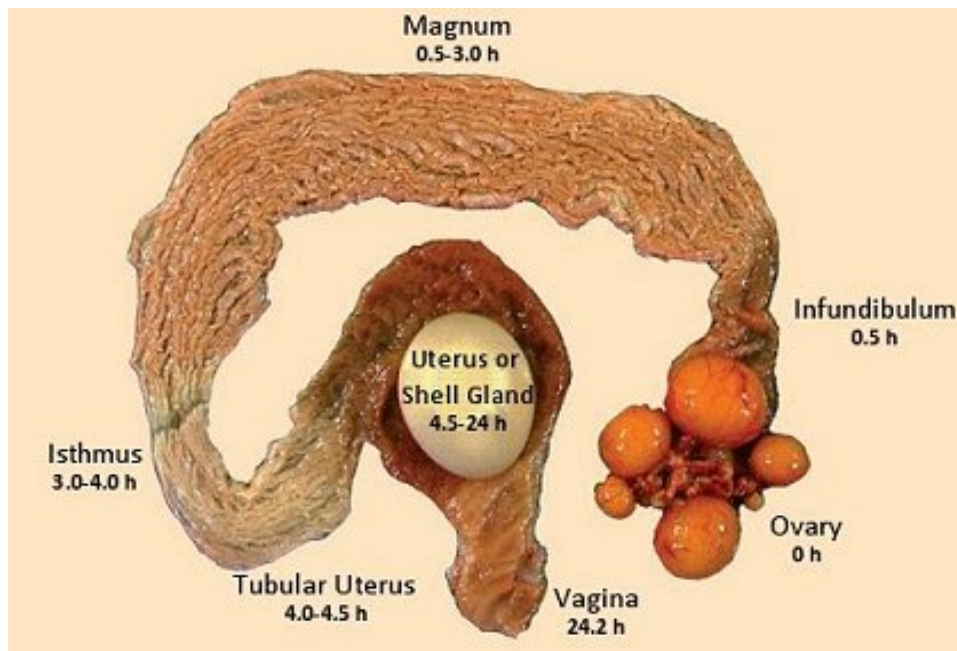
Ca metabolism is a complex game

Ca metabolism is regulated by various hormones such as calcitonin, 1,25-dihydroxyvitamin D3 (calcitriol), and parathyroid hormone. Estrogen, androgens, and prostaglandins also appear to have an important role in avian Ca metabolism.



Source: Ricardo (2008)

Egg formation and Ca requirements

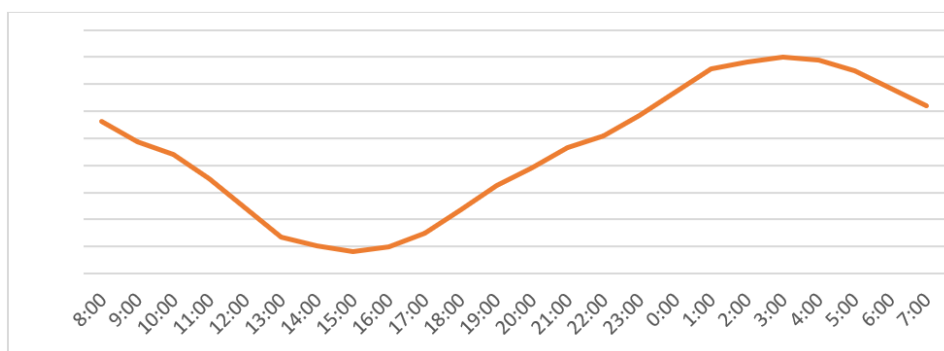


[Source](#)

A hen ovulates approximately 15 to 75 minutes following oviposition[xi], and the ovum takes approximately 4.25 hours to reach the shell gland[xii], at which point calcification takes approximately 17 hours[xiii]. Hens generally lay eggs in the morning and early in the afternoon[xiv]. The hen can use the Ca and P made available through diet to recover medullary bone losses during the next 5 hours after oviposition.

Once the ovum reaches the shell gland, the demand for calcium naturally increases greatly as eggshell formation progresses. The highest eggshell mineral accretion takes place 5 - 15 hours after the egg enters the shell gland[xv], which normally happens later in the afternoon and during the night preceding egg laying.

Hourly Ca requirements for eggshell calcification



Ca dietary requirements vary with species, age, breeding status, and dietary levels of vitamin D. Egg-laying birds and growing birds require more Ca than adult non-breeding birds.

Common eggshell quality problems and

causes

In many cases, the source of eggshell problems can be detected by recognizing the specific markers. For instance, cracked, soft-shelled or corrugated eggs can be caused by saline water, or the impact of mycotoxins; shell-less eggs can be caused by improper amounts of Ca, P, Mn or vitamin D3, as well as by infectious bronchitis or Newcastle disease IB. However, among the main causes of eggshell quality issues is heat stress.

In hot temperatures, increased respiration rates can cause an increase in CO₂ loss. The reduction of the pool of bicarbonate ions can result in respiratory alkalosis and an increase in blood pH[xvi]. A reduction in bicarbonate ions in the shell gland reduces the formation of CaCO₃ and decreases shell quality.

[Under heat stress](#), birds will also tend to decrease their feed intake during the day to reduce diet-induced thermogenesis. Calcium intake is therefore also reduced, and shell quality decreases as a consequence.

3 solutions for eggshell quality in older layers

Midnight feeding in hot climates

At midnight, when temperatures are typically cooler, the addition of one to two hours of light can help the birds increase feed consumption[xvii]. Midnight feeding can also have the benefit of providing a dietary source of Ca to support eggshell formation during the night and reduce reliance on bone reserves[xviii].

Nutrition supplements

Along with Calcium, some micro-minerals can also influence eggshell quality. Zinc, Manganese and Copper act as cofactors of enzymes involved in the mineralization process during eggshell formation. Although European Union legislation restricts the use of high levels of these minerals, several studies in layers indicate increased egg shell resistance by increasing the dietary concentrations of microminerals. Using organic forms of Zinc, Manganese and Copper appears to be an alternative way to increase the absorption of these minerals, as organic forms appear to be more digestible than inorganic forms. Considering the high cost of organic minerals, a mix of organic and inorganic forms of critical minerals could be a better option.

Liquid Ca supplements

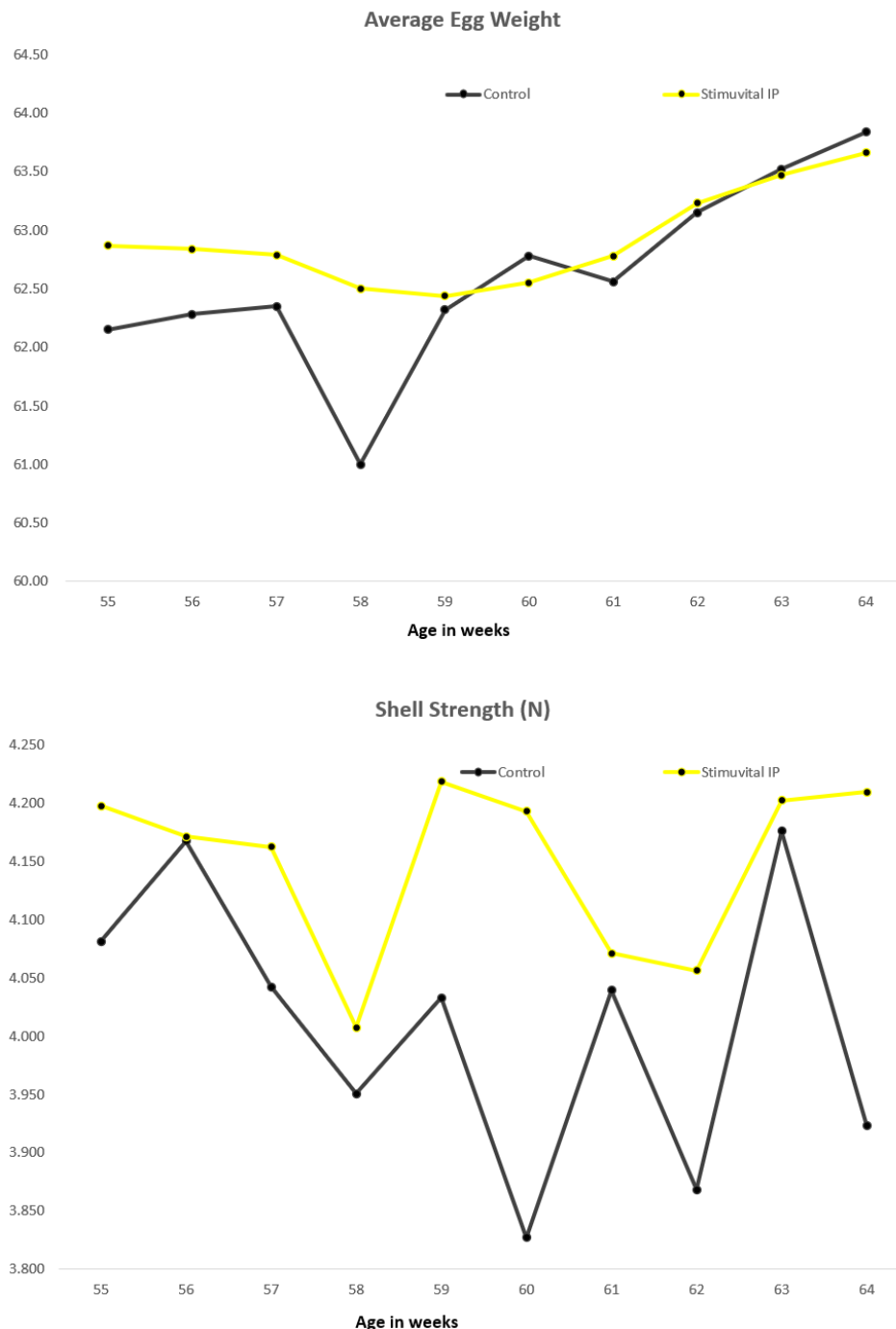
If a hen is fed a diet containing only a small-particle Ca sources, such as finely ground limestone, the intestine will be deprived of a source of Ca during the night, when demand for Ca is highest. At that point, the hen will be entirely reliant on bone Ca to support eggshell formation. A combination of Ca supplementation through water additives can be a good alternative as readily available Ca to the hen to support high Ca requirements during the late afternoon and through the night. Liquid Ca additives also offer further precise and user-friendly application.

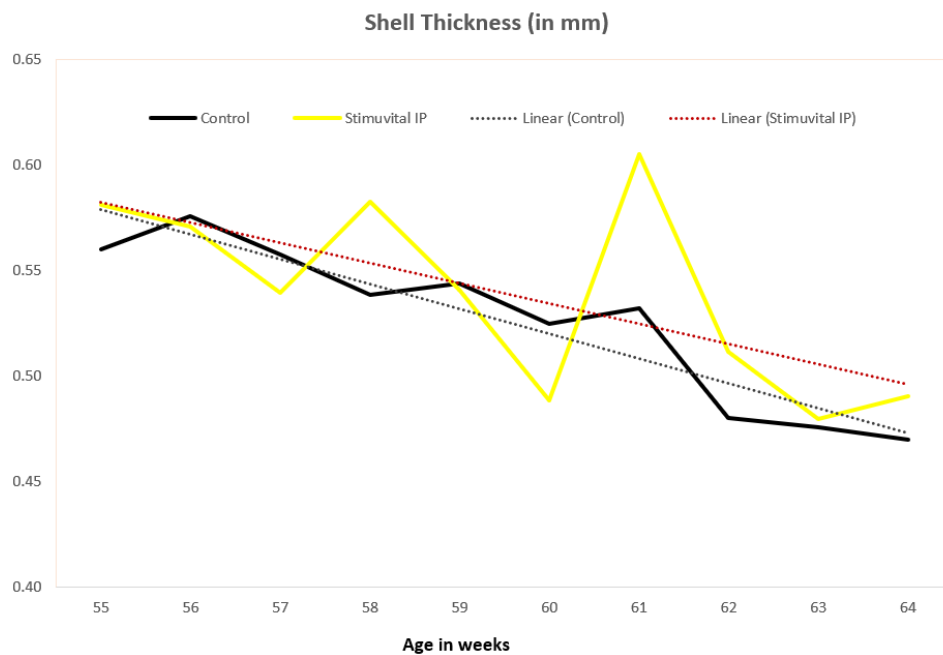
Stimuvital IP: a liquid solution from EW Nutrition

Stimuvital IP (formerly Shellimprover) is a liquid nutritional additive for laying hens, supporting the quality of eggshells and bone health. It contains a cocktail of Ca and vitamins whose benefits in laying birds are well proven through field studies, existing literature, and years of market experience.

Benefits proven in Australia field trial

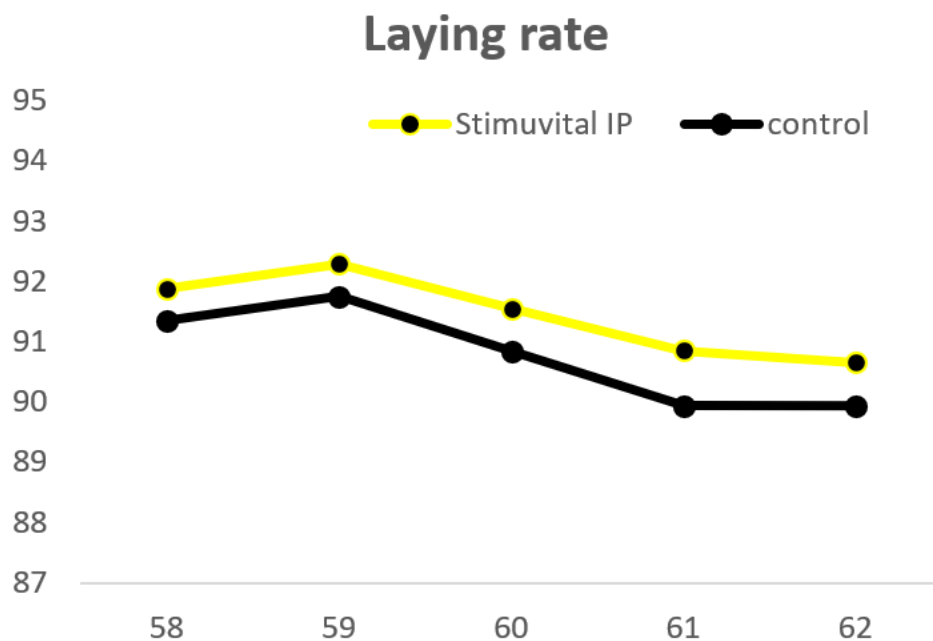
22,500 layer birds were split into two equal-size groups, one of which (11250 birds) was supplemented with Stimuvital IP for 3 days every two weeks, starting from age 53rd to 63rd week. Improvements in eggshell thickness and strength could be noticed after the application of Shellimprover. Egg weight was consistent in Stimuvital IP -supplemented birds. 3 days every fortnight by using the Easy@ system. In total, the 11250 birds received (2 (feed lines) x 3 (times per days) x 265ml x 3 (days) x 6 (week 53, 55, 57, 59, 61, 63) 28620ml of Stimuvital IP.

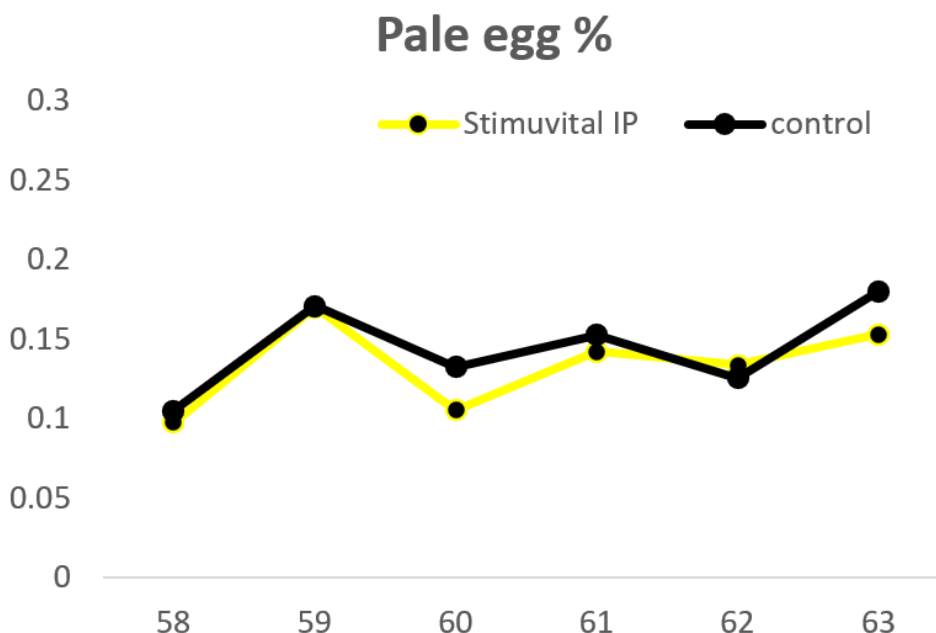
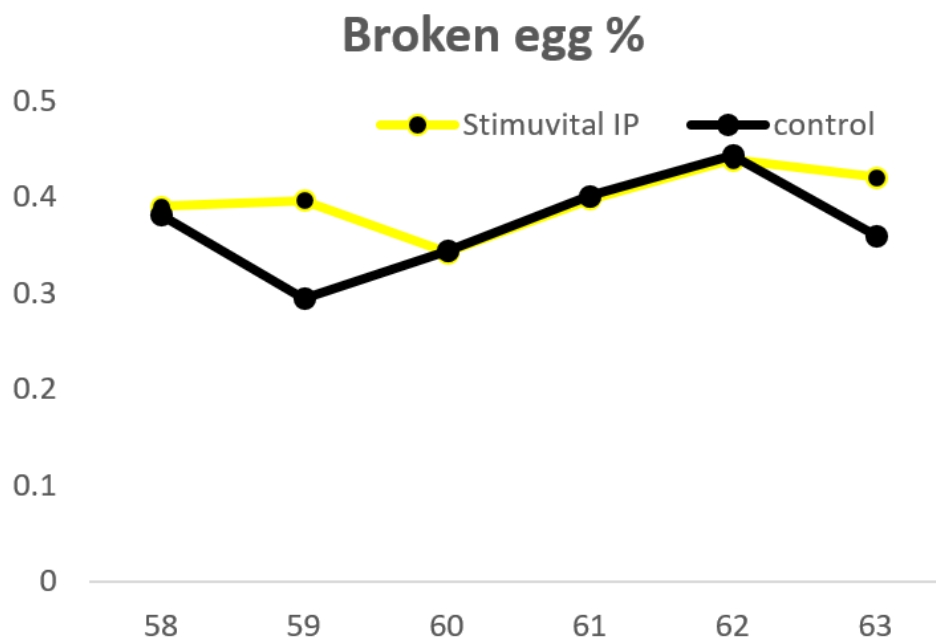




Benefits proven in China field trial

The field trial was carried out on a commercial layer farm. A control group and Stimuvital IP (Shellimprover) group had 50,000 birds each. Stimuvital IP was supplemented for 3 days every two weeks, starting from age 57th to 62nd week. The Stimuvital IP supplementation improved eggshell quality, including eggshell thickness, laying rate, and number of saleable eggs during the trial period.





Optimizing quantity, quality, and overall profitability for layer producers

Ca concentration in the blood is controlled by many interacting feedback loops that involve Ca, phosphate, PTH, vitamin D₃, and calcitonin. Supplementation of Vitamin D₃ can help maintain skeletal and shell quality in high-producing laying hens^[xxiv].

Stimuvital IP offers an essential cocktail that caters to the additional requirements of Ca and vitamins in older laying birds. It thus supports Ca metabolism and eggshell quality. And, in the end, better eggshell

quality reduces broken egg percentage and optimizes the number of salable eggs and profitability for layer producers.

Notes

- [i] Pelicia *et al.*, 2009; Bello and Korver, 2019
- [ii] Nys *et al.*, 2004
- [iii] Orban and Roland Sr, 1990
- [iv] Bello and Korver, 2019
- [v] Driggers and Comar, 1949
- [vi] Roland Sr *et al.*, 1975
- [vii] Wistedt *et al.*, 2019
- [viii] Miles *et al.*, 1983
- [ix] Wen *et al.*, 2019
- [x] Silva, 2017; Akbari Moghaddam Kakhki *et al.*, 2019
- [xi] Beuving and Vonder, 1981
- [xii] Roberts, 2004
- [xiii] Hincke *et al.*, 2012
- [xiv] Samiullah *et al.*, 2016; Hunniford *et al.*, 2017
- [xv] Hincke *et al.*, 2012
- [xvi] Franco-Jimenez *et al.*, 2007
- [xvii] van Staaveren *et al.*, 2018
- [xviii] Harms *et al.*, 1996
- [xix] Chowdhury, 1990
- [xx] Leach and Gross, 1983
- [xxi] Zhang *et al.*, 2017
- [xxii] Atteh and Leeson, 1983
- [xxiii] Atteh and Leeson, 1985
- [xxiv] Silva, 2017; Akbari Moghaddam Kakhki *et al.*, 2019

Full references are available upon request.

How producers keep the egg supply chain going amid COVID-19



The Covid-19 pandemic has increased consumer demand for eggs. This article discusses how the egg supply chain, from layer farms to supermarkets, works amid disruptions caused by Covid-19.