Egg Focus

1. Setting the scene

According to the American Egg Board 'eggs are all-natural and packed with a number of nutrients. One egg has 13 essential vitamins and minerals in varying amounts, high quality protein and antioxidants, all for 70 calories. Eggs' nutrients can help you with weight management, muscle strength, brain function and having a healthy pregnancy. Particularly important for aiding healthy brain function and pregnancy is choline, which is amply present in eggs'.

So, it is easy to comprehend that man has eaten eggs since history began and why today they are regarded as a key component of man's diet. Out of this has grown an important sector of global livestock production that is not hindered by any religious beliefs or taboos.

Table 1 shows the top five countries for egg production and it can be seen how production is to some extent dependent upon a country's population, but other factors come into play with regards to per capita egg consumption (Table 2).

Country variations

Countries vary in the proportion of their production coming from large, intensive farms. At one end of the spectrum we have the situation of smaller farms still being the corner stone of a rural economy, whereas at the other end we have part of production reverting to smaller farms, for example with the return of outdoor production.

An important factor in this is consumer perception (or misperception!) about egg production. Why else would a major fast food chain only use free range eggs and a major supermarket claim that its bakery products are only made from free range eggs?

Country	Egg production in 2011 (tonnes)	% of world total
China	23,897,000	36.6
USA	5,415,600	8.3
India	3,490,000	5.3
Japan	2,482,628	3.8
Mexico	2,458,732	3.7

Table 1. Top five countries for egg production (FAOSTAT data, 2014).

In fact, much of the recent history of egg production in more developed countries has been influenced by consumer perceptions, such as the anti-cage movement, the anti-GMO lobby and others.

Events such as the emergence of Salmonella enteritidis in the last quarter of the last century also did much to mould the egg industry of today. For example, the vast majority of UK flocks now comply with the Lion Code which grew out of a desire to satisfy customers that salmonella in eggs was an issue of the past.

If we look at the history of the egg sector, much of the success of today's industry goes back to intensification, which became possible with the control of respiratory diseases, primarily through vaccination, and the control of enteric disease, primarily through medication and the advent of cages which separated birds from their faeces and, latterly, vaccination.

If we had not been able to manage diseases such as Newcastle disease, infectious bronchitis, coccidiosis and the like, today's modern, progressive industry might never have occurred.

Genetics

Our understanding of nutrition also paralleled the evolution of the table egg sector by providing rations which more closely fitted the table egg layer's needs.

Over time genetics has fine-tuned egg production and feed efficiency with egg numbers steadily increasing and food utilisation steadily improving.

Nowadays, global layer genetics is in the hands of very few companies and genetics focuses on far more than just bird performance. Issues such as disease/salmonella resistance, egg quality and shell strength are among the traits featuring in modern genetics programmes.

Consumerism

Then along came consumerism which had its say in the evolution of egg production. The key areas that consumerism impacted on were salmonella freedom, housing – with the move to alternative systems, and bird welfare, with issues such as cages and beak trimming.

With the increasing need for agriculture to be more efficient (sustainable) and not to waste key primary resources, such as land and water, one sometimes wonders how far this move into alternative systems can go? Will a second generation of intensification occur?

Table 3 is designed to make you think. The answers to many of the questions you may have will be covered in future editions of Egg Focus in International Poultry Production. ■

Table 2. Top five countries for per capita egg consumption (FAOSTAT data, 2009).

Country	Consumption per person per year (kg)
Paraguay5.5	19.5
Japan	19.1
China	18.5
Mexico	18.1
Denmark	16.8

Table 3. Comparison of intensification and alternative systems including free range.

	Intensive systems	Alternative systems including free range
Land utilisation	Very good	Often very poor
Biosecurity	In the hands of farm management	Often in the hands of the Gods
Social structure	Birds in small stable groups with defined pecking order	Birds in large groups with variable pecking orders
Feed management	Usually very good	Variable – often wastage though spillage and consumption by other animals
Water hygiene	Only drink supplied water where the hygiene can be easily managed	Often access to other water supplies so less control
Bird inspection	Sometimes not easy – but easy to check individual birds	Easier, but harder when one wants to take a closer look
Stress	Easier to avoid trigger stresses like poor weather	Birds more susceptible to natural adversities
Disease	Limited number – most of which can be managed	Return of many old diseases such as tuberculosis and worms
Staffing	Large number of birds per staff member. Better working conditions	Higher staff cost per hen

Egg Focus

2. Salmonella

Today there are still consumers who unfortunately regard salmonella and eggs as being synonymous. This goes back to the Salmonella enteritidis in eggs problem, which started in the late 1980s and took over a decade to control. This was done by giving a significant amount of protection to hens via vaccination. Even so, in some parts of the world this serotype is still an important egg borne zoonotic pathogen.

In those regions where fowl typhoid exists S. gallinarum can be found in eggs but it is of little zoonotic consequence. Other serotypes occur from time to time and if they get into a large or mega operation their importance in a country or region can be significant.

When it comes to eggs, salmonella can either be found in the egg or on the shell surface. The former arise by one of two means. Firstly, some invasive salmonella serotypes, of which S. enteritidis is a good example, invade the hen's body and then invade ova in the ovary. These ova then become egg yolks.

For many years this was considered to be the only such route. However, there is now also some evidence to suggest that the salmonella may get on to the surface of ova or be incorporated into the first albumin to be laid down, which is that laid closest to the yolk.

These salmonella can then either remain in those locations or migrate into the yolk as the egg ages and the integrity of the yolk membrane reduces.

Salmonella inside or by the yolk are in that part of the egg which is least cooked in boiled eggs and therefore often survive!

For this reason, soft boiled eggs with nice runny yolks present a real risk of food poisoning in man.

Ironically, such eggs are popular with the very young and very old – two groups of people that are more susceptible to salmonella infections.

Salmonella on the shell surface can easily get into the egg contents when the eggs are cracked open. Also, if salmonella get into or near the eggshell pores these can provide a route of entry into the egg under certain conditions.

At the farm level we must provide food that is safe. We can not pass the responsibility for ensuring eggs are safe on to the consumer, especially since some eggs are eaten raw, for example, in mayonnaise.

Remain salmonella free

The approach to follow is to start salmonella free and then to protect that status so our flocks and eggs remain salmonella free.

At the outset our poultry houses, bedding material, feed, water and day old chicks must all be salmonella free and ideally we should confirm this by microbiological testing. It is also sensible to use suppliers, such as feed mills and hatcheries, that have a proven salmonella freedom track record.

We may choose to use an acid or inclusion of a similar product in the feed as an extra safeguard.

S. enteritidis is quite capable of avoiding all the rigours of the terminal clean down and sanitation by taking up residence in the farm's mouse, rat or lizard populations and then infecting the next flock to be placed. Thus, attention needs to be given to ridding your farm of such populations in the terminal cleaning programme.

If we have started with a salmonella free flock we must endeavour to maintain that status. This is all about biosecurity which has recently been covered in our Poultryhealth BYTES.

Use of vaccination

Another way to counter salmonella infection in our flock is to enhance or boost its ability to counter infection and this can be achieved via vaccination.

Two options are dead vaccines, which need to be injected into every hen, and live vaccines ,which can be applied by one of the mass vaccination routes. Vaccines have been used very successfully in many countries.

An area which many overlook is that if you are processing eggs on the farm, have you got a source of contamination in your processing area?

Screen and check flocks

Whatever your situation one thing which is especially important is to screen and check your flocks and products. A basic rule of screening for salmonella is 'the more you look the more you are likely to find'. This has one or two consequences.

Firstly, if you adopt a minimalistic view to sampling, your programme might not be robust enough to withstand a legal challenge if something goes wrong.

Secondly, vaccination should not be viewed as a tool for eliminating salmonella but rather as one of greatly minimising salmonella to the level that they are of little significance, for example, they are unable to create an infective dose.

For those of you who are statistically minded this is one reason why we can have sampling programmes with pre-defined confidence limits.

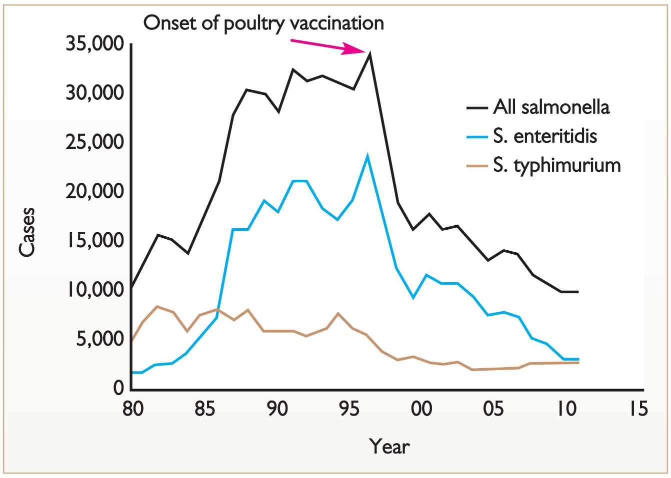
This can be complicated by the fact that in some situations, for example feed, salmonella are not homogeneously distributed throughout the material.

Finally, we need to use a laboratory that is competent at isolating salmonella. We also need to know what we mean by negative and positive results. All negative says is the test that we were using was unable to detect salmonella in the sample tested. It is not saying that the material tested is free from salmonella.

For this reason many laboratories report what they once reported as 'negative' as 'not detected' today. In other words, tests on similar samples from the same source on another day could well generate a different result!For this reason it is not prudent to give guarantees on salmonella status.

The sensible approach is to list the tests done and, if it is the case, state that all these samples yielded 'not detected' results. Then you let your customer carry the risk associated with the interpretation of the results and you have issued a statement that you can defend should the need ever arise. ■

Fig. 1. Human cases of salmonella in England and Wales (1980-2011).



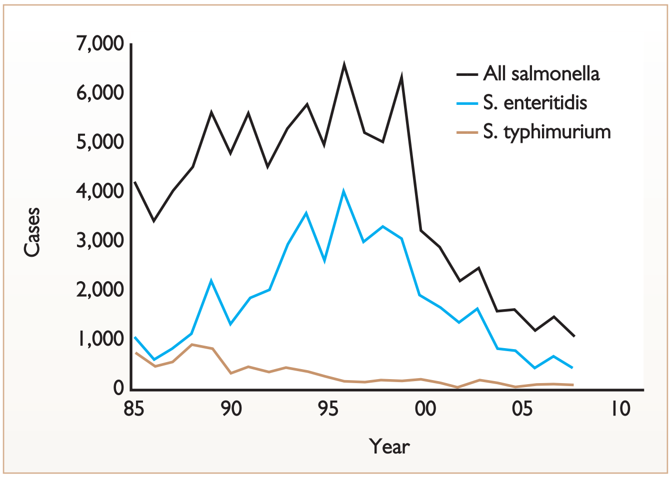


Fig. 2. Japanese data. Note the similarity to the British data in Fig. 1.

Egg Focus

3. Feeding for optimal egg production

by Dr Robert Van Wyhe, technical service nutritionist, Hy-Line International.

The art of formulating layer rations is a delicate balance between feeding for high performance and economics. There is constant pressure to improve efficiency and lower operational costs while increasing production. Producers must examine many factors to achieve optimal production; focusing on the rearing period, calcium levels throughout life, and feeding to production throughout lay will address many challenges that are seen in the field.

Feeding the pullet

In order to optimise egg production during lay, producers must maximise pullet performance. Growth should follow the bodyweight curves recommended by the breeding company. Feed programs and nutrient density in the diet should be adjusted to meet these targets.

If management interventions during rearing reduce feed intake or weight gain (for example vaccination or beak treatment), producers can select a more dense diet used earlier in rear to help offset this growth loss. Average flock body weight is important, but uniformity of the flock is critical as well. In addition to health or management challenges, low uniformity can be a result of insufficient energy, protein or feed presentation in the rearing diets or as a result of poor mix, separation or ingredient quality.

Feeding during lay

A successful feeding program during lay will have several diets available that match nutrient density and intake within each phase of production.

Producers should work with their nutritionist and feed mill to ensure quality feed is provided at the appropriate time of production.

early in lay, compared to the rest of lay, in response to high nutrient demand to meet her requirements for production, growth, and bone development.

Diet formulation changes may need to occur weekly to ensure diet density accurately matches feed intake. Many nutrients can be undersupplied early in lay, causing the birds to go into a negative nutrient balance.

Sub-optimal feeding of calcium early in lay reduces the skeletal mass of the hen and will reduce shell quality late in lay.

Fig. 1 demonstrates calcium intakes below recommended levels until approximately 24 weeks of age.

Hens coming into lay may reach a high performance peak even though nutrient intakes are sub-optimal, but persistency will suffer. Sub-optimal feeding of protein or energy can cause post-peak dips.

Undernourished hens will drop out of production until a point at which appetite overcomes the dietary deficiency.

These hens will often have other dips or lack persistency in lay. A well developed diet matrix that varies nutrient levels in the rations according to production and intake will help reduce the possibility of underfeeding early in lay and reduce the chance of post-peak dips.

Diet selection made solely by age is another issue that can harm production. Producers should regard the breeder-recommended programs as a guide for the average flock.

The aim should be to feed each flock according to the potential that it is showing.

This will allow the flock to maintain a high rate of production while maintaining the desired egg weight and target bodyweight.

In Fig. 2 lysine levels from 40-41 weeks were dropped, before production indicated the need. Hen day and egg mass production had a corresponding drop a week later.

This is an example of the potential pitfalls of feeding to age rather than production. Carefully monitoring feed and performance over time will allow a producer to better anticipate the necessary timing of dietary changes in the future.

Genetic selection is leading to more stable egg weight curves as the bird matures through production. In some situations it may be necessary to avoid excessive egg size as a result of over consumption of nutrients.

An egg shell consists of approximately 2.2g of calcium carbonate regardless of size. As size increases, the egg shell becomes thinner and more susceptible to breaks.

Overweight birds and overfeeding amino acids, specifically methionine and cysteine, and dietary oils increase the size of the egg produced.

If egg size becomes an anticipated issue, producers should initiate a program to restrict egg size increases when eggs are 2-3g below the desired maximum for the operation. Attempts to reduce egg size after eggs have become too large are not always successful and usually reduce production as well.

Summary

To optimise production a producer must adopt a consistent approach of:

- Proper nutrition through the pullet stage and peak production.
- Feeding to production rather than age.
- Consistent monitoring of feed mixes and quality. ■

Fig. 1. A comparison of standard versus actual calcium intake in a commercial Hy-Line W-36 flock from 18-65 weeks of age.

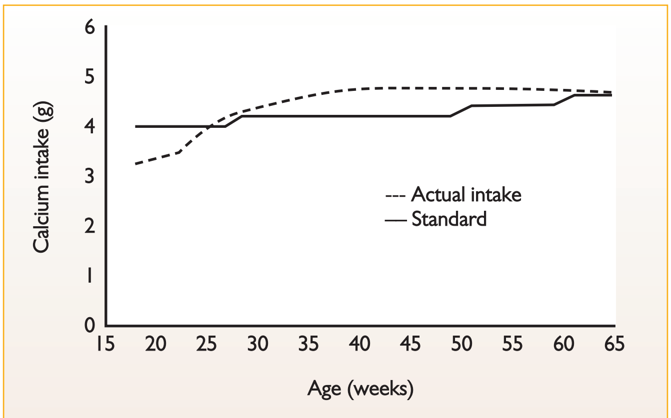
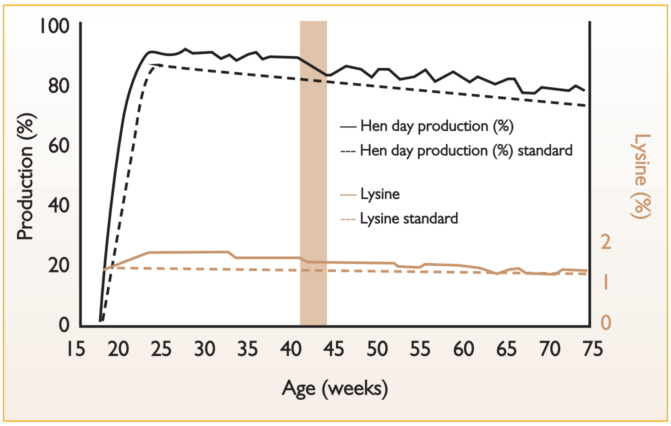


Fig. 2. Hen day performance and lysine intake of a commercial Hy-Line brown flock from 18-72 weeks of age (Hy-Line Eggcel program).



Egg Focus

4. More saleable eggs

by Novus International

For any layer operation getting more saleable eggs is the key to increasing profitability. Challenges such as dirty eggs, broken and weak shells can lead to poor interior quality due to potential contamination from external pathogens. The most effective way to achieve the highest production possible is by boosting flock performance through optimal nutrition.

In order to consistently produce high quality eggs, nutritionists must provide a balance of key nutrients to sustain the health of the bird to ensure product quality.

Trace minerals are one aspect of the diet that should be given more consideration. Maintaining adequate mineral balance supports shell strength and the internal structure of the egg.

Additionally, trace mineral nutrition plays an increasingly important role as hens age, ensuring continued production of plentiful, high quality eggs and overall health of the hen.

Optimal performance can only be reached by meeting all nutrient requirements of the animal, as well as minimising all health challenges.

Metabolic activities

Zinc, copper and manganese are vital to realise optimal performance, particularly in layers, as these trace minerals have specific roles in metabolic activities directly related to eggshell formation.

These trace minerals are essential cofactors of enzymes required for the formation and calcification of the collagen matrix of the egg.

When adequate supplies of these minerals are not provided to the hen, egg quality can suffer. For example, a lower shell mass can result when a layer is deficient in manganese, and egg production decreases with a zinc deficiency.

These trace minerals work together to develop the shell and internal structures of the egg.

Adequate copper supplementation serves as the foundation of a quality eggshell as it is crucial for shell membrane formation. It is an important micro-mineral for crosslinks of the microstructure within the eggshell.

Zinc is a critical cofactor for calcium metabolism enzymes, which work to form the shell. Zinc nutrition also becomes increasingly important late in lay as hens' production may start to decline. Additionally, manganese is essential to mucopolysaccharide synthesis, which is a necessary component for eggshell formation.

Feeding high quality chelated trace minerals offers significant advantages when it comes to layer performance and egg quality. Chelated trace minerals offer an improved technology that helps animals reach optimal nutrition even with reduced mineral supplementation. By including lower concentrations of chelated trace minerals, this not only alleviates excretion concerns, but also significantly improves production efficiency.

As a highly bioavailable mineral source, Mintrex chelated trace minerals are absorbed and used by the animal to a much greater degree than comparable trace mineral supplements. Considering the risk of mineral loss, combined with potential lost production, the superior value is clear.

Research conducted by Sun et al (2012) showed eggshell thickness was significantly increased with the inclusion of Mintrex in the diet when compared to a diet supplemented with inorganic trace minerals.

Additionally, eggs were sampled at 52 weeks of age and assessed for freshness after 10 days of storage.

The supplementation of chelated trace minerals significantly increased Haugh units after 10 days of room temperature storage, which shows the superior stability of eggs from Mintrex fed hens.

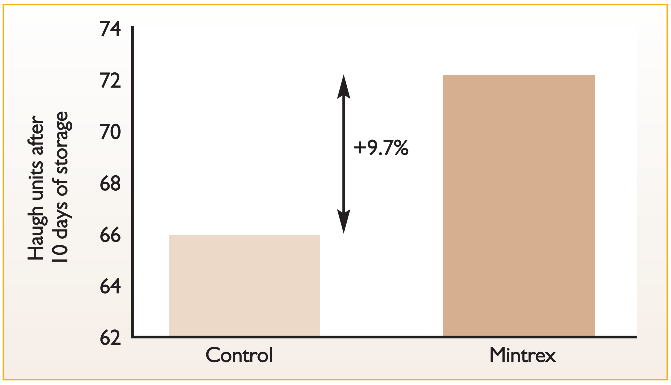


Fig. 2. Increased egg freshness.

Improved eggshell

A trial comparing a diet supplemented with Mintrex and a normal feeding program showed improved eggshell quality late in lay, as well as improved egg weights without compromising shell strength.

Comparisons with both inorganic trace minerals and other organic trace mineral sources indicate Mintrex improves tissue supply of zinc, copper and manganese, and has a direct beneficial effect on connective tissue and bone development in poultry.

In layers, these effects support improved bird health, eggshell strength and egg quality factors which are critical to today's industry performance parameters.

In addition to performance improvements, feeding layers a special mineral enriched diet can enhance the mineral content of eggs they produce.

Zinc, copper and manganese can be passed on to the egg in higher levels, provided the animal is fed a highly bioavailable source of those trace minerals.

Consumers eating these eggs will then have the added benefit of consuming more healthy minerals in their diet.

Mintrex chelated trace minerals consistently deliver more essential trace minerals to the bird, while also minimising mineral excretion. That translates into healthier layers, more efficient production and ultimately, improved profitability for the producer. ■

References are available from the author on request

Fig. 1. Improved egg shell quality, with less cracked and broken eggs, in commercial layers from 72-81 weeks of age.

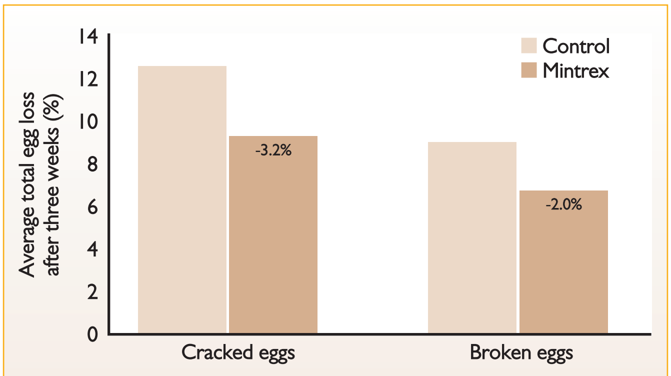
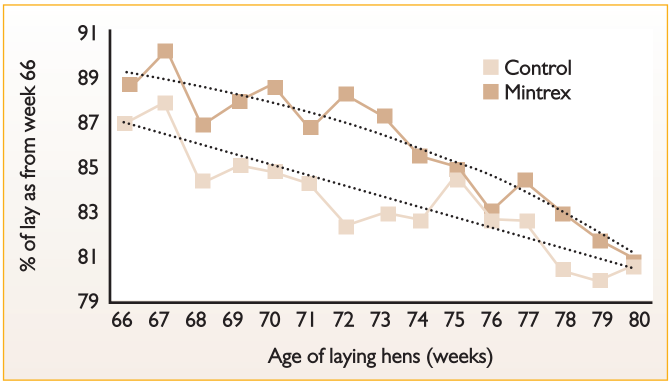


Fig. 3. Increased laying rate, especially in late lay. After week 66, the laying rate remained higher for Mintrex birds.



Egg Focus

5. E. coli peritonitis in layers

A discussion with Dr John Brown, Zoetis Inc.

The layer industry has made big strides to reduce the prevalence of Escherichia coli peritonitis, but producers still need to guard against losses from this potentially devastating disease, says John Brown, DVM, a senior technical services veterinarian with Zoetis Inc. "Without efforts to protect layers against peritonitis, I have seen increased mortality from the disease persist for as long as 10 weeks," he says.

E. coli peritonitis – an inflammation of the peritoneum due to the E. coli bacterium – can occur as an opportunistic pathogen secondary to respiratory diseases such as Mycoplasma gallisepticum or infectious bronchitis. However, it is now known that E. coli can be a primary cause of peritonitis in layers.

"Peritonitis can strike without warning, and in fact, in some cases there are typically few clinical signs other than high mortality. You'll find dead birds in cages, or in cage-free production, birds tend to be found dead in their nests," John says.

Sometimes, late in lay, E. coli peritonitis will present initially as a slower rise in mortality and is more likely related to calcium depletion and ensuing cloacal prolapse, which enables E. coli to invade the oviduct and abdomen.

Hens in aviary systems face an increased risk of trauma or injurious pecking. Breaks in the skin or vent trauma can become ports of entry for bacteria.

Unfortunately, antibiotics are usually ineffective during an outbreak of E. coli peritonitis. "Antibiotics used to be helpful, but only for a short time," he comments.

"Mortality would drop after a week or so, but when the antibiotics were pulled, mortality would come right back up. Treatment would have to be repeated over and over; the problem was never solved and treatment costs could be tremendous.

"It has become clear that the best defence is vaccination coupled with strict biosecurity," John continues.

Mistaken identity

The veterinarian cautions that careful diagnosis is important. Although bacterial peritonitis is commonly due to E. coli, it can be easily confused with peritonitis due to fowl cholera bacteria.

Another problem that can be confused with E. coli peritonitis is non-bacterial egg-yolk peritonitis, which occurs when ova are ruptured into the abdomen by rough handling of birds, when birds are moved after they have already started producing or when birds are nervous.

"I always recommend culturing birds with peritonitis to get a proper diagnosis. That is the only way to make sure that initiating E. coli vaccination is likely to be effective," he says.

The veterinarian suggests culturing the abdomen, liver or spleen, and to obtain a more sterile sample from the field, long bones can be collected for bone marrow culturing.

Routine immunisation of flocks for E. coli with a modified-live vaccine is now common in most layer operations, John reports, adding that it has helped reduce both mortality and the severity of E. coli peritonitis while easing the financial impact of the disease.

"Some producers do not vaccinate until an outbreak occurs, but I think it is more cost effective to vaccinate before the disease strikes," John adds.

For best results, John recommends vaccinating flocks in the pullet house twice.

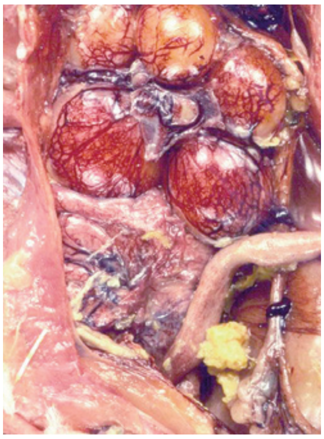
The vaccine is usually sprayed on at day of age, then again during the grower stage at 12-14 weeks of age. The vaccine can be administered in water, "but I feel that spraying the vaccine on the birds gives better protection," he says.

Biosecurity

John emphasises that biosecurity is just as important as vaccination for combating E. coli peritonitis because the more pathogenic forms of the bacterium can be present in the environment.

E. coli can be tracked from one poultry house to another and spread via dust from fans. The litter and water can be contaminated with E. coli, which birds can aspirate, resulting in peritonitis.

Good ventilation – particularly efforts to reduce ammonia levels – and water sanitation are an important part of E. coli infection prevention.



Prominent and congested blood vessels, particularly in the ovary, are compatible with an inflammatory/infectious process. Note the yellowish fibrinous and caseous exudate in the abdomen.

Biosecurity also includes restricting visitors on layer farms. Anyone entering a poultry house should be required to wear clean clothes.

Visitors must be required to wear coveralls, shoe covers and a hairnet, and everyone should wash hands and use a disinfectant footbath upon entering and leaving.

The tyres of vehicles entering and leaving the farm should be disinfected and there should be pest control procedures in place.

These measures, coupled with vaccination of layer flocks against E. coli, can go a long way toward controlling E. coli peritonitis and reducing losses from the disease.

To learn more about flock health solutions visit www.zoetis.com

by Rafael Lera, ISA, France.

Heat has a negative impact on layer performance, mainly due to lower feed intake, which is, in fact, a natural adjustment made by the hens in order to maintain their body temperature when environmental conditions (high temperature or humidity) jeopardise their ability to lose heat.

The three basic methods for heat exchange with the external environment are conduction (contact with the litter), convection (heat transfer to cool air around the bird) and radiation.

When the temperature increases, blood circulation to peripheral areas is increased for higher heat loss through combs and legs, and wings are opened up.

Further increases in temperature, exceeding 30°C, will trigger the next step in thermoregulation and birds will accelerate their breathing rate (panting), allowing a heat loss of approximately 0.6Kcal per g of evaporated water via the respiratory route. However, the temperature perceived by the bird, usually called 'apparent temperature', will also depend on relative humidity and air speed.

This is the reason why, in warm and humid conditions, the air feels hotter than it actually is (heat index) and why using any system to increase the speed of air movement around the birds in the layer house will create more comfortable conditions, since heat loss by convection is increased (wind chill effect).

Increasing air speed

Proper ventilation is essential to supply fresh oxygen and remove not only harmful gases, like carbon dioxide and ammonia, but also dust and excess humidity.

Increasing the air speed in the layer house is very effective in fighting heat, since it improves heat loss by convection without changing the relative humidity, which means keeping the capacity of reducing body temperature through pulmonary evaporation.

As a rule of thumb, it is considered that an increase in air speed of 0.20m/second reduces the apparent temperature by around 1°C. This seems valid for temperatures below 30°C; above 35°C the efficacy of air speed is progressively reduced.

In open-sided houses with natural ventilation it is not easy to increase air flow, but installing circulation fans is a helpful alternative.

The efficiency of this system will depend on the number of fans, fan power and lay out: the goal is to improve air circulation at bird level.

Prevent heat stress

To prevent heat stress, fans should start working before the in-house temperature goes beyond 26°C.

Forced-ventilated houses, usually working on negative pressure, are much more efficient for controlling the climate in hot conditions.

The so-called tunnel system, with air flowing at one end of the building and being extracted by the exhausting fans installed at the opposite end, makes it possible to obtain high air speeds, that are uniform and easy to regulate.

Air velocity will depend on total fan capacity and the cross sectional area of the house. The more sealed the poultry house, the better the efficiency of the system.

In hot areas, this type of layer house is usually designed to ensure a ventilation capacity of at least 5m³ per hour/kg of live weight, and allowing a high air speed, up to 2.5m/second and beyond at bird level. In cage systems, it is more difficult to get a uniform air movement, and in some cases air speed in the cages can be only 75% of the aisle air speed.

Evaporative cooling

Evaporative cooling is based on the cooling effect produced when water vapour is added into air entering the house, since energy used for evaporation is taken from the air in the form of sensible heat.

This system, by reducing the ambient temperature, allows the bird to lose more heat by convection (by exchange with the ambient air) and is very efficient in dry areas.

However, this also has some disadvantages or limiting factors. The cooling effect will depend on relative humidity of the outside air (the higher the humidity the lower the effect) and as water is evaporated, moisture in the house increases, reducing the ability of the birds to lose latent heat by respiratory means. In fact, evaporative cooling systems should work during the drier periods of the day and stop when relative humidity is too high to avoid extreme heat and humidity discomfort which can lead to mortality. A variety of different systems can be used:

- **Fogging nozzles**

They are usually installed at the air inlet or, in some cases, in front of the circulation fans. The system is not expensive to install, but not as efficient as pad cooling and should be properly adjusted to avoid leaking, wet spots in the poultry house or even damping the birds. Nozzles require good water quality or filtering to avoid clogging.

- **Pad cooling**

Working as a kind of 'wet filter', they are mainly made of cellulose, but plastic models are also available, and are placed over the air inlets and wetted by dripping water over them.

The system requires a sufficient exhausting fan capacity, so the air entering the house can be pulled through the dampened pad and cooled as water evaporates off the pad.

Cooling pads require proper maintenance and cleaning to avoid algae buildup or being clogged by lime scale and will need to be periodically replaced.

Management factors

There are certainly many other factors related to house design, orientation, insulation etc that play a key role in environmental house conditions which are not going to be reviewed here.

However, it is important to remember that flexible management is also a very helpful tool to reduce the negative impact of heat. For example:

- Avoid high stocking density. In floor systems perches can be used.
- Provide good quality cold water. In hot climates a layer can consume up to 300ml of water. This will help birds to regulate their body temperature and compensate for the moisture losses due to panting. Water tanks and pipes should be well insulated and drinking lines be regularly flushed.
- Use a feed of good texture (75% of the particles between 0.5-3.2mm). Layers have preference for coarse particles and a drop in feed intake is critical in hot conditions.
- Adjust the time of feed distribution in order to maximise feed intake during the cooler hours of the day. Make sure feeders are empty once a day, in the middle of the day. This will encourage feed intake.
- If local regulations allow it, install a one hour 30 minutes to two hour period of light in the middle of the night (midnight snack) for extra feed intake. ■

Table 1. Heat index in poultry (adapted from Nilipour, 1996).

Relative humidity (%)	Temperature (°C) 21.1	23.9	26.7	29.4	32.2	35.0	37.8	40.6	43.3
0	17.8	20.6	22.8	24.6	28.3	30.6	32.8	35.0	37.2
10	18.3	21.1	23.9	26.7	29.4	32.2	35.6	37.8	40.6
20	18.9	22.2	25.0	27.8	30.6	33.6	37.2	40.5	44.4
30	19.4	22.7	25.5	28.8	32.2	35.5	40.0	45.0	50.5
40	20.0	23.3	26.1	30.0	33.8	38.3	43.3	50.0	58.3
50	20.5	23.8	27.2	31.1	35.5	41.6	48.8	57.7	65.5
60	21.1	24.4	27.7	32.2	37.7	45.5	55.5	65.0	
70	21.1	25.0	29.4	33.8	41.1	51.1	62.2		
80	21.6	25.5	31.1	36.1	45.0	58.8	69.4		
90	21.6	26.1	31.1	38.8	50.0	65.5	76.6		
100	22.2	26.6	32.7	42.2	56.1	74.4			

Egg Focus

7. Calcium

by Samia Messaoud, Techna France Nutrition, Groupe Techna, France.

Eggshell quality is one of the major concerns for egg producers. Downgraded eggs account for 6-12% of all produced eggs. This rate increases drastically after 45-50 weeks old: it can reach up to 20% at the end of laying period. Solidity is therefore a crucial condition for ensuring the profitability of egg producers and the safety of consumers.

The major component of eggshell is calcium (about 95% of the shell is calcium): it is deposited at the later stage of egg formation. After the deposition of egg membrane in the uterus, calcium carbonate is precipitated on the egg membrane by shell glands.

About 2.5-3.5g of calcium is needed for every egg formed; since demand for calcium is very high during lay, avian species are able to resort to special and unique ways to mobilise the needed quantity of calcium by an increasing intestinal absorption and drawing upon their bone reserves.

Dietary sources

Calcium levels in layer diets normally range from 3.5-3.8%. Calcium can be provided by several sources such as limestone, oyster shell, calcium phosphates, calcium sulphates, meat and bone meal.

The source, physical characteristic and solubility of calcium influence its retention time in the gizzard. Even though authors often diverge with regards to optimal type of calcium source, particle size and its suitable proportion etc, larger particle calcium sources are commonly known to increase calcium retention in the gizzard.

This time length is closely correlated to eggshell quality. Thus the longer calcium stays in the gizzard, the more it maintains adequate blood concentration all night long (period of shell formation).

All the techniques and conditions designed to support calcium availability at the end of the night for eggshell calcification should therefore be applied: time of feed distribution; distribution of coarse calcium particles late in the evening; midnight feeding; providing calcium of suitable particle size in the feed.

Intestinal absorption

During lay, calcium intestinal absorption in the duodenum and upper jejunum by passive ionic diffusion is not sufficient to satisfy the high demand for it. Hence these calcium supplies are usually completed by a specific active diffusion allowed by a calcium binding protein called calcibindin.

Once calcium provided in the diet reaches the blood vessel, it can be used directly for eggshell through the shell gland. If this mineral is not available in sufficient supplies as the shell is forming, hens can use their own bone reserves.

Medullary bones

The process of providing calcium through bone metabolism to form eggs is unique to avian species. Osteoclasts of medullary bones are bone-resorbing cells. When the egg is located in the shell gland, these cells supply calcium for eggshell formation by resorption of their rufflers borders.

On the contrary, when the egg is located in the upper part of the oviduct (infundibulum, isthmus or magnum) the resorption process does not occur.

Other dietary factors

Other dietary minerals and trace elements also play a major role regarding eggshell quality. Most studies have shown the impact of phosphorus, vitamin D3, manganese, copper, zinc, chromium, etc on eggshell quality. Other ingredients can also contribute to the same purpose.

A study focusing on Protical 4+ (Techna France Nutrition) demonstrated the positive effect of this product on eggshell quality.

Experiments were conducted on two groups each comprised of 240 white commercial layers. Two different treatments were applied:

- Group A: this control group was fed with a layer feed containing 3.6% of calcium of which 80% was in coarse carbonate form.
- Group B was fed the same nutritional level as Group A except that 0.2% of Protical 4+ was added.

The supplementation phase began as animals reached 61-70 weeks old for the two groups.

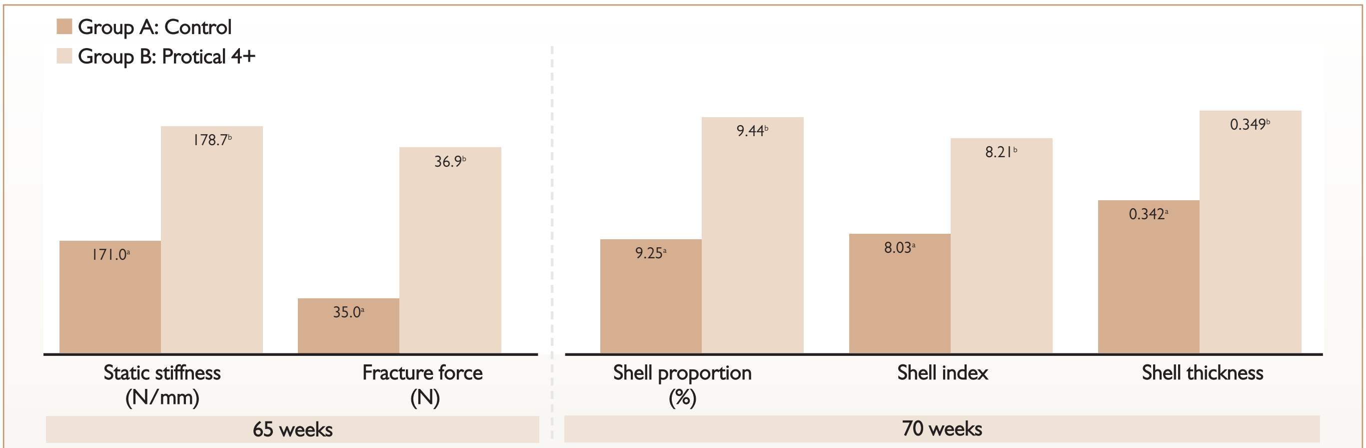
In this study, Group B (Protical 4+ at 0.2%) ended up having a better shell quality than Group A (control feed). Higher shell quantity and increase in shell thickness was observed in Group B as opposed to Group A. Shell index was also higher for Group B than Group A.

In addition, eggshell solidity (static stiffness and fracture force) was improved by using Protical 4+ supplementation in feed.

Moreover, Group B achieved higher values regarding bone strength criteria (rigidity, maximum force and fracture force).

As a conclusion, the use of supplements like Protical 4+ in layer feed has proved beneficial on eggshell quality without interfering with bone mineralisation and solidity. Using Protical 4+ can definitely be efficient for strengthening the eggshell. ■

Fig. 1. Effect of Protical 4+ on egg quality. [a,b] ***means followed by different letters are significantly different ($P<0.05$).***



Egg Focus

8. Quality criteria

by A. Förster, D. Cavero and R. Schulte-Drüggelte, Lohmann Tierzucht GmbH, D-27454 Cuxhaven, Germany.

Breeding programs for commercial layers pay attention to a large range of egg quality traits in order to optimise the revenue of egg producers and to satisfy the requirements of table egg consumers. However, layer eggs are not only used for human consumption, but also for hatching chicks.

Good hatchability and a reduced spread of hatch are therefore important selection goals in a breeding program for improving the number and the quality of chicks produced by parent stock.

Furthermore, the impact of egg quality traits on hatchability is also measured and taken into account.

There are many factors that affect hatchability, for example the environmental conditions during egg collection and egg handling and specially the configuration of the incubation process will have a great impact on the hatchability results.

Furthermore, egg characteristics greatly influence the process of incubation and are responsible for its success. While some egg quality parameter affecting hatchability can hardly be influenced by the management of a breeder flock, others can.

The aim of this article is to review the latter and derive general recommendations for layer breeder management with special focus on egg weight and egg shell quality.

Table 1. Estimated genetic correlations between reproductive traits and egg quality traits in two white egg layer strains (Adapted from Cavero et al. 2011).

Trait	Egg weight	Shell strength
Line C		
Fertility	-0.08	+0.06
Hatch of set eggs	-0.43	+0.19
Hatch of viable embryos	-0.46	+0.22
Line D		
Fertility	-0.18	+0.10
Hatch of set eggs	-0.48	+0.27
Hatch of viable embryos	-0.52	+0.29

	Line 1		Line 2	
	Normal (95.7%)	Crack (4.3%)	Normal (97.9%)	Crack (2.1%)
Embryo mortality (< day 18)	6.0%	12.5%	7.5%	32%
Hatch of viable embryos	77.7%	57.0%	85.1%	63.2%
Egg weight loss until day 15	8.8%	10.8%	9.8%	12.7%

Table 2. Early plus mid embryo mortality (%), egg weight loss during incubation (%) and hatch of viable embryos (%) of cracked and normal eggs of two brown egg layer strains. The differences between normal and cracked eggs were significant (P<0.001) for the three presented traits.

Table 1 shows the genetic correlations of egg weight and shell strength and with fertility, hatch of set eggs and hatch of viable embryos.

A predisposition for high egg weight is related to low hatchability, whereas one for high shell strength is related to high hatchability.

There is not only a genetic correlation between egg weight and hatchability, but also a phenotypic one.

Eggs between 55 and 60g do hatch better than heavier eggs, but also very light eggs show reduced hatchability.

Table 2 shows the results of a hatchability test performed with two brown egg laying strains. Before egg setting, different egg quality traits were measured including the dynamic stiffness of the egg shell.

The crack detector allows the identification of eggs with very small hairline cracks, which are not visible by the eye.

Although the egg weight loss of the cracked eggs during incubation was not excessively high, the hatchability was clearly reduced.

The test results suggest that egg shell quality is crucial for optimum incubation results. The management and feeding of layer breeders should be designed to support shell quality by an adequate calcium supply and a healthy liver. In order to achieve optimum hatchability the average egg weight below 60g should be targeted.

Special attention should be also paid to all hatching egg handling procedures to avoid cracked eggs. ■

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