The importance of genetics in determining egg quality

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For at least 30 years tremendous efforts have been made to improve egg production and egg quality, but priorities in breeding companies have evolved throughout this period. Initially feed efficiency and increasing egg number was the primary goal and only latterly has egg quality traits received more attention.

Nowadays, with the improvement of laying persistency and therefore continuously lengthened production cycles, egg quality has become more and more crucial in the breeding program.

It is well established that in general the egg quality (for example egg shell, Haugh unit, etc) decreases as hens age.

Consequently, to further improve egg mass, it is necessary to reduce the number of downgraded eggs by selecting hens for higher egg quality at the end of the laying period.

In addition, as different egg industry and consumer demands are getting more specific and more important, the uniformity of the external and internal egg quality becomes one of the major traits in selection.

Breeding for egg quality

Improvement of egg production has to be accompanied with an optimal egg quality, well accepted by consumers. Egg quality traits become more and more important as production systems and consumer demands are diversifying.

Uniformity and high quality of eggs is an important issue for the companies involved in egg packing and marketing.

Numerous packaging centres are equipped with state-of-the-art technologies allowing the detection and the rejection of eggs with lower egg quality.

Egg quality is an important trait for packing stations, distributors, consumers or breaking plants.

Generally speaking, the egg quality is good and uniform at the beginning of the laying period but some defects still exist and can be reduced. In fact, selection for earlier egg numbers has sometimes resulted in a higher percentage of downgraded eggs during the initial period of egg production (soft egg shells, double yolk eggs, white banded eggs). Efforts to decrease those defects have reduced their prevalence.

Egg quality declines naturally with flock age, but it is possible to delay this tendency through genetic selection. For many years, Novogen has focused a lot on different traits related to egg quality to be able to meet the market needs of egg shell quality or breaking plant demands.

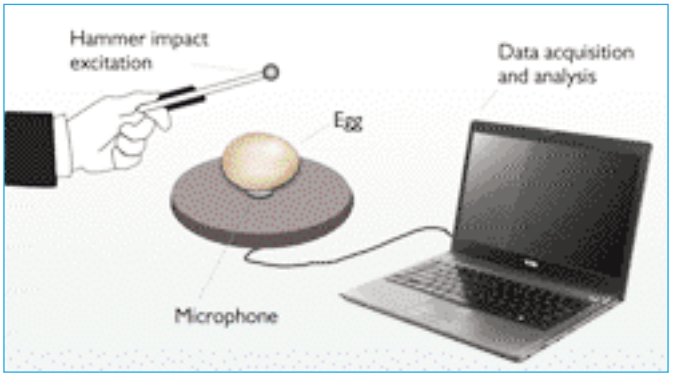
Egg shell strength

The improvement of eggshell strength has been stronger after 65 weeks of age compared to younger flocks due to the larger variability. Increase of egg shell strength at the beginning of lay is not necessary and can have negative effects on other traits, like hatchability. It is the objective to keep uniform egg shell strength along the production cycle.

The shell strength is measured during the whole production cycle. From start of lay until more than 80 weeks of age the measurements of shell resistance are done.

As well as destructive methods, non-destructive methods are also being used.

Fig. 1. Evaluating shell strength.



Fracture force measurement.

Non-destructive methods are the measurement of specific gravity, which reflects the quantity of shell deposit, and the static stiffness (deformation of the shell) which reflects part of the resistance.

The egg is compressed between two metal plates putting a constant increasing pressure on the egg (4mm/min) in order to register the deformation value between 1 and 15 Newton.

Concerning the destructive methods, the geneticist has various indicators at his disposal. Shell weight, shell index (quantity of shell deposit per surface unit) and shell thickness help to evaluate some aspects of the shell strength related to the quantity of shell deposit.

The fracture force is the maximum force to break the shell. The average fracture force value varies between 35 and 45 Newton (3.5-4.5kg) depending on the genetic line and the age of the hen.

To complete the shell strength evaluation, dynamic stiffness can be used. As shown in Fig. 1, a mechanic impulse at the equator of the egg with a small hammer causes a vibration which is registered with a microphone on the opposite side of the egg.

The value depends on the sample's geometry, the density and elasticity of the material. This value gives an estimate of the shell strength and the presence of unidentified cracks.

All these measurements are correlated to each other and the sum of all information leads to a better consolidation of the shell strength evaluation.

In addition to those measurements, special attention is paid to the presence of roughness on the shell, misshaped eggs or any other defects throughout the whole production period.

Egg shell colour

The intensity and the uniformity of egg shell colour from the beginning until the end of the laying period and within the same age are the main objective for both white and brown egg layers.

- The white egg colour is generally more uniform. This is a very consistent criterion in Leghorn lines, with the exception of some individuals that can produce cream coloured eggs at the beginning of the laying period. Even if this criterion does not require a selection pressure as high as for the brown eggs, a selection pressure is applied to continue to improve the uniformity and the intensity of the white colour.

- For the brown egg market this trait is of greater importance as there is a larger variation in colouration of the shell. Consumers are not just looking for brown eggs; they are also seeking high egg colour uniformity. In many countries eggshell colour is an important buying criterion. State-of-the-art technologies

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used at numerous packing stations can detect and thus reject eggs which show not enough colour or colouration defects (for example dark spots or non consistent colours).

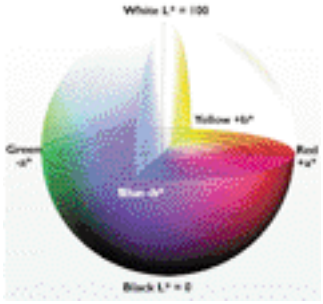
Genetic determinism is the prime factor in eggshell colour variation.

It controls the deposition of pigments within the shell (polyphirins) and around the egg's superficial cuticle. The intensity of the shell colour declines naturally as flock age, but it is possible to delay the phenomenon.

The egg shell colour measurement is done with a colorimeter (chromatograph), which allows the description of a colour in a "L*a*b* three-dimensional space that is very well correlated with human vision and where equal distances are more or less representative of perceived colour differences.

- The component L* represents the light clarity whose values go from 0 (black) to 100 (white).
- The component a* represents the range of the red axis (positive value) to green (negative), and zero is neutral (grey).
- The component b* represents the range of the yellow axis (positive value) to blue (negative), and zero is neutral (grey).

The chromatograph technology enables us to considerably accelerate genetic improvements of eggshell colour and notably the colour intensity.



Measuring colour intensity.

Today the selection is mostly done after 50 weeks of age to maintain good colour intensity at the end of the laying period and above all to keep a good uniformity.

In addition to those measurements, special attention is paid to the presence of dark spots, eggshell discolouration, or any other defects throughout the whole production period.

Internal egg quality

- Haugh unit and meat or blood inclusions are selected in pure lines. The Haugh unit is considered to be related to freshness of the egg and has a big importance in some specific markets. It characterises the albumen height for a constant egg weight and is measured during the whole production cycle with fresh eggs, but also after a longer period of storage. After cracking the egg, the albumen height is measured at a constant distance (0.5-1.0cm) from the yolk.

- Another important internal quality parameter is also the percentage of egg yolk. Selection to increase feed efficiency might have negatively affected the egg yolk/egg white-ratio and modified the dry matter content of the egg as increasing the water content is likely to be metabolically cheaper. An increased number of breaking plants in many developed countries consider this trait as an important factor for the industry today.

Conclusion

With longer cycles of production, egg quality measurements are becoming traits of huge importance in breeding programs. More than the quality itself, the uniformity of egg quality traits can be seen as the main requirement.

In addition to traditional measurements and visual selection, genomic development can be a useful tool to respond quickly and more precisely to changing consumer demands.

Through the use of genomic tools, a different genetic approach can also be defined to suit the market needs best. ■

References are available from the author on request

Measurement of egg shell colour is done with a colorimeter.