Concepts of Eggshell Quality[1]

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Concepts of Eggshell Quality

Much information has been learned about eggshell quality during the past fifty years. During this period of time, the genetics of the chicken,diets, house design and management practices have changed dramatically. In the future it is very likely that additional changes will have to be made by the commercial egg industry. No matter what changes occur, the eggshell needs to be as strong as possible to maximize the number of eggs reaching market.

Many factors influence eggshell breakage. Eggshell breakage is directly related to the quality of the shell. It is impossible, even with current knowledge, to correct all eggshell quality problems. We can, however, make significant reductions in the number of eggs lost due to poor shell quality. This can be accomplished if one realizes that no one factor is usually responsible for egg breakage. Many factors are known to be related to eggshell quality including: adequacy of nutrition, flock health problems, management practices, environmental conditions, and breeding. The following are some of the major factors associated with eggshell quality. A brief account of each factor is provided.

The Eggshell Itself: What do we know?

Most good quality eggshells from commercial layers contain approximately 2.2 grams of calcium in the form of calcium carbonate. About 95% of the dry eggshell is calcium carbonate weighing 5.5 grams. The average eggshell contains about .3% phosphorus and .3% magnesium and traces of sodium, potassium, zinc, manganese, iron and copper. If the calcium from the shell is removed, the organic matrix material is left behind. This organic material has calcium binding properties and its organization during shell formation influences the strength of the shell. The organic material must be deposited so that the size and organization of the crystalline components (calcium carbonate mostly) are ideal, thus leading to a strong shell. The majority of the true shell is composed of long columns of calcium carbonate. There are other zones that are involved in the self-organization giving the eggshell its strength properties. Thus, shell thickness is the main factor but not the only factor that determines strength. Presently, dietary manipulation is the primary means of trying to correct eggshell quality problems. However, the shell to organic membrane relationship is also critical to good shell quality and must be considered.

An eggshell that is smooth is desirable as rough shelled eggs fracture more easily. Large sized eggs will usually break more easily than small ones. The main reason for this is that the hen is genetically capable of placing only a finite amount of calcium in the shell. As the hen ages and the eggs get bigger a similar amount of calcium has to be spread over a larger surface. Therefore, controlling the rate of egg weight change can influence eggshell quality as the hen ages. Controlling feed intake by changing the temperature inside the layer house influences egg size. It must be remembered that many factors can influence the amount of calcium being laid down by the hen. Just because an eggshell is thick does not necessarily mean that it is strong. Sometimes a thinner eggshell is stronger than a

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thicker eggshell. The reason for this is due to the shape and organization of the organic and inorganic components of the shell.

Feeding

The importance of adequate nutrition in providing the hen what she needs to maintain adequate eggshell quality is obvious. A hen lays approximately 250 eggs per year which corresponds to 20 times the quantity of calcium in her bones at any one time. Therefore, the calcium requirement of the laying hen is great. It can be calculated that during the 20 hours that are required to form an eggshell, 25 milligrams of calcium must be deposited on the egg every 15 minutes. This amount of calcium is the total amount of calcium in a normal hen's circulatory system at any given point in time. The laying hen is also not 100% efficient in extracting calcium from the available sources in the diet. Therefore, many times the diet has to furnish in excess of 4 grams of calcium to the hen daily. Calcium availability values are sometimes not known and it must be remembered that higher daily intakes are needed when the availability values are known to be low.

A high phosphorus content in the feed and excess chlorine may have a negative effect on eggshell quality. It is possible that these two elements act negatively on eggshell quality through their influence on acid-base balance (pH) in the blood. The importance of adequate vitamin D intake by the hen is obvious and it is essential for proper calcium and phosphorus utilization. However, excess vitamin D and its metabolites have not been shown to benefit eggshell quality when normal hens are already consuming adequate vitamin D. Other vitamins and trace minerals, when fed above the hen's requirements, have failed to improve eggshell quality.

Environment

Usually, eggshell quality is not as much of a problem in cooler environments as compared to hot environments. One of the contributing factors causing poorer eggshell quality in hot weather is hens not consuming adequate feed. This can lead to problems in body weight, egg production, egg size, and eggshell quality if measures are not taken to assure adequate daily nutrient and energy consumption. When environmental temperature becomes excessively hot, feed intake decreases and energy becomes the first limiting factor to the hen. Inadequate consumption of amino acids, calcium, phosphorus and other nutrients can usually be corrected by adjusting the nutrient density of the diet. However, it must also not be forgotten that in hot weather, unlike cooler weather, the laying hen has to make critical "life sustaining" physiological adjustments in order to cope with the increased environmental temperature.

The laying hen, through panting, resists the rise in body temperature during periods of heat stress. At the same time, the acid-base balance in the bird's blood is changed. We sometimes forget that the laying hen has to cool her body in extremely hot environments and this will shift her physiological priorities from producing eggs and maintaining an adequately calcified eggshell to that of staying alive. In such situations maximum egg mass (egg production times egg weight) along with maximum eggshell quality are difficult to achieve with any age bird.

Disease and Eggshell Quality

Not all diseases which affect chickens cause a decline in eggshell quality. However, egg production will usually decline. An example of a disease that can affect the numbers of eggs and not necessarily the quality is infectious laryngotracheitis. Other common viral diseases such as egg drop syndrome (EDS), avian influenza (AI), Newcastle disease (ND) and infectious bronchitis (IB) may produce severe effects on eggshell and internal quality. Many times the total number of eggs is not influenced even though the egg records indicate a drop in total collectable eggs. This is due to the increase in non-collectable eggs (shell-less or ultra-thin shells) that are lost under the cages. This is a common occurrence with EDS. It has been established that the EDS virus affects only the shell gland but with ND and IB every portion of the reproductive tract can be affected.

If one disease had to be singled out as being the one responsible for the majority of the economically significant production losses in egg layers it would have to be Infectious bronchitis. Infectious bronchitis virus, a coronavirus, has a preference for the mucus membranes of the respiratory and reproductive tracts.

The kidney is also affected by certain IB virus strains. Not only is eggshell quality affected but internal quality also declines. Watery whites are very common and can persist for long periods after egg production returns. Also, an IB outbreak can result in a pale colored shell in brown shell.