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VARSHA VAHINI

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From the Editor's Desk

We have a plesure in bringing out this edition which covers the most important topic - **Shell Quality**.Egg breakage and thin shell eggs are too common now a days and layer farmers are baffelled about the cause.We have compiled key pionts from an eloberate reveiw by Dr SV Ramarao,reknowned scientist and Poultry consultant published in World Poultry Science Journal.We thankfully acknowledge his his consent for publishing this compilation.We are sure this would provide some practical insight about shell quality.

Wishing You a Profitable Farming

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SHELL QUALITY

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Introduction

Eggshell is an architectural marble. The eggshell is made up of organic matrix accounting for about 2% of the weight of the shell in which calcite crystals are deposited. It is highly prone to breakage with any mechanical stress. The problem is more severe when the shell quality is poor. The reduced shell quality increases the risk of eggshell breakage. But, the shell enables the egg to withstand considerable biological and mechanical abuses while still maintaining its structural integrity and the wholesomeness of its contents. About 7.77% of eggs collected are either shell less, thin shelled or ultra-thin shelled. The incidence of eggshell defects and cracked eggs increased up to 21% of total eggs produced in hot tropical environment The approximate loss incurred by the layer industry in India due to poor shell quality is calculated at Rs.2175.6 million per annum. Cracked and or broken eggs still persist as the serious problem, not only in financial terms to the industry but also in terms of the loss of a high quality human food.

Eggshell abnormalities

The most common shell abnormalities found are thin shelled, shell less, body check, translucent, corrugated, pimpled and doubled eggs. The occurrence of a particular abnormality is specific to the cause. Some times multiple causes may leads to a single abnormality. The eggshell quality also depends on the rate of egg production, the longer the oviposition interval the more the shell is deposited.

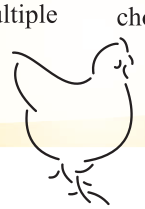
Body-check

The eggshell may become cracked during the course of its deposition in the uterus of the hen. The secretion of additional calcific material may then seal the cracks. The shell is obviously weakened. When the length of photoperiod is increased from 16 to 19 hours, the incidence of body checked eggs increased from 7.7 to 18.3%, respectively. Manipulation of the lighting regimen to minimize the activity of the bird at the time of shell formation is considered as a solution to minimize the incidence of body checks.

When the birds are subjected to handling stress, the production of body checked eggs increases. It is suggested that under heat stress, adrenaline is released causing strong contractions of shell gland that break the eggs in the uterus.

Thin shelled / shell less eggs

Imbalance in dietary concentration of calcium, phosphorus, cholecalciferol, magnesium, manganese, copper, fluorine or



contamination of feed with pesticides, fungicides, fungal toxins, stress, disease outbreaks, improper lighting schedules, old age, hard water etc may cause thin shelled or shell-less eggs depending on the severity of cause.

Corrugated eggs

Corrugated eggs are produced when the layer suffers from infectious bronchitis, lathyrogen toxicity, fed on pesticide-contaminated feed or copper deficient feed. In copper deficiency and lathyrogen toxicity, eggs are usually larger than normal size due to excesses water accumulation in the albumen.

Double eggs

Double eggs are found when one egg is retained in the shell gland beyond the normal length of time and is still there when the next egg reaches the shell gland

Pre-laying nutrient levels

Layers require more calcium in diet than growers, because of higher calcium requirement for shell formation. In most commercial practices, about 2% calcium is provided in diets at the onset of egg production. The most ideal method of increasing the dietary calcium level from about 1% to 2% is at 18 weeks of age (approximately 2 weeks prior to the start of egg production). This level is maintained until about 5% production is reached, at which time a shift is made to the higher calcium level. Supplementation of diet with calcium (2%) during the pre-laying period resulted in an increase in bone calcium storage

Calcium, phosphorus and cholecalciferol in layer diet

Sound eggshell formation in the laying hen depends on the availability of calcium and carbonate ions during shell formation in the uterus. The modern layer producing 300 eggs with an average egg size of 55 g, requires about 650 to 700 g calcium which is equivalent to more than 30 times that found in the body of a hen.

Calcium Requirement

Calcium metabolism is highly dynamic in laying hen. Shell quality was significantly reduced with in 24 hours of feeding low-calcium diet. At sub-optimal levels of dietary calcium (less than 2.0%), the skeleton supplies 30 - 40% calcium required for shell calcification. At optimum level of dietary calcium (3.6% or more), majority of eggshell calcium is derived from feed. Optimum dietary calcium levels reduce the need for skeletal calcium, thus reducing the need for dietary phosphorus also.

Dietary calcium requirement also depends on calcium source and particle size of calcium source. WL layers require about 3.0% calcium in diets based on oyster shell grit for optimum shell quality, where as in the diets based on powdered limestone, the requirement was 3.5% .For optimum shell quality and egg production, WL layers require a minimum of 3.5 to 4.0 g calcium / bird / day. The calcium requirement is also based on age of the layer. Commercial WL layers require higher dietary calcium levels (4.00 to 4.25 g / hen / d), at latter part of production compared to young pullets (37-52 weeks) for optimum shell quality. After peak production, when most hens are laying and average feed consumption falls below 100 g / hen / day, it is important to increase dietary calcium . The increase in calcium requirement with age could be due to the increased calcium requirement for increased egg weight with age and also due to reduced ability of calcium absorption form the digestive system.

Particle size and solubility of calcium source

The process of shell formation in the shell gland increases approximately 7 hours post ovulation and reaches peak as the shell is being formed and the secretion rate decreases 2 - 3 hours before oviposition. Ionic calcium should be available at the required level especially at peak hours of shell formation, which usually takes place during 2300 to 0400 hours.
Residence time of calcium sources in the digestive system is an important factor for formation of eggs with optimum shell quality : Pulverized limestone gets absorbed and excreted quickly, so calcium may not be available during the period of eggshell formation. Large particles of calcium supplement may lodge and slowly dissolve in gizzard and thereby calcium will be available during night when the shell calcification process is in active phase.

Phosphorus requirement

A bell shaped response curve can be constructed with regard to the response of shell quality to dietary phosphate with an optimal level of 0.4 to 0.5% of total phosphorus in a corn-soy diet.

Cholecalciferol requirement

Cholecalciferol (vitamin D_3) plays a vital role in eggshell formation. This vitamin is involved in the synthesis of calcium binding protein (CaBP), which facilitates the calcium absorption / transportation in intestine and shell gland. A level of 300 ICU of vitamin D_3 / kg diet is the optimum level for WL layers (NRC, 1994). The movement of calcium across the shell gland occurs through the association with the vitamin D- dependent CaBP. Carbonic anhydrase hydrates CO_2 in uterus to produce carbonate ions for shell formation. The carbonic anhydrase activity is related to calcium secretion in the uterus .

Toxicity

Calcium: Higher levels of dietary calcium (4.5%) decreased the shell quality

Phosphorus :Excess dietary phosphorus combines with calcium and forms insoluble calcium phosphate, thereby reduces absorption of essential minerals required for egg-shell formation. Calcium, divalent trace minerals like manganese, magnesium, zinc, copper, iron etc. are excreted and become unavailable during shell formation resulting in poor shell quality.

If skeleton stores are not depleted, their replenishment will not be necessary and the need for phosphorus in this role largely disappears. When the skeletal calcium is utilized for eggshell formation due to dietary imbalance of calcium, phosphorus and vitamin D_3, the phosphorus from bone source will get accumulated in the blood. The excess phosphorus in blood will reduce the shell quality. Birds which lay soft shelled and shell less eggs had higher plasma phosphate levels.

Feeding time

The shell strength of eggs laid in the morning is not as good as that of those laid in the afternoon.The normal practice of feeding the layers during the early hours of the day makes the nutrients unavailable to the birds during eggshell formation. Midnight feeding will make the calcium available during eggshell formation. In this practice, the lights are switched on for a period of half an hour at midnight and the hens are allowed to eat. This provides a source of calcium during the critical phase of shell formation.

Protein and amino acids

The poor shell quality associated with larger egg size during latter part of egg production can be improved by decreasing the dietary concentration of protein, methionine, linoleic acid etc. Shell quality was significantly improved by reducing the dietary methionine and non-phytin phosphorus and by improving the calcium content

Eggshell quality of layers fed low dietary protein (17.0 Vs 19.5%) was greater than higher dietary protein diet ,however it should be balanced with Energy.

Trace minerals

Certain trace minerals have a significant role in formation of shell organic matrix. Copper and manganese are associated in shell membrane formation, shell morphology and shell thickness.

- Copper is required for cross-linking of lysine in shell membrane and cartilage formation.
- Manganese plays a pivotal role in synthesis of protein mucopolysaccharide, which is the major component of the shell organic matrix and Uterine ATPase requires magnesium ion for maximum activity

Ascorbic acid

Ascorbic acid synthesis is impaired at higher environmental temperature. Ascorbic acid has been suggested to promote mineral mobilization from skeleton thereby increase plasma calcium. Ascorbic acid is also essential for synthesis of steroid hormones, shell organic matrix and bile acid formation. Eggshell weight and specific gravity is increased with supplementation ascorbic acid.

Molting and age of the bird

Decline in eggshell quality primarily with aging process is a normal physiological phenomenon in layers. Further it is established that the decline in shell quality with increase in age of hen is due to a continuous increase in egg size and reduced duodenal calcium up take. The older birds have the ability to use most, if not all, of the phytin phosphorus, thereby suggesting the phosphorus requirement decreases as the hen ages and hence, reducing the dietary phosphorus with hen age improves shell quality.

The improvement in egg production in force molted hens is due to a reduction in the number of shell less eggs, a consequence of improved calcium metabolism. Force molting restored the age-related decrease in the activity of "25-OH-D_3 1- hydroxylase" in older layers

Lighting schedule

Normally 30 to 40% of the shell calcium comes from the medullary bone, but the utilization of skeletal calcium could be reduced to 15% if dietary calcium is supplied throughout the calcification period. Layers reared in intermittent lighting programme or providing the light between 2300 to 0100 hours would enable the bird to consume and absorb calcium for current shell formation, thereby, produce eggs with better shell quality. Although it has been reported that 13 or 14 hours of light will result in maximum egg production, many farmers still use a light period of 17 to 18 hours. Specific gravity was significantly increased in hens given the 15 hours photo period compared to 18 hours. Generally, it is recommended that calcium source needs to be given at least 3 hours before lighting ends for better shell quality.

Higher environmental temperature

The ambient temperature during the most part of the year is above the ideal temperature zone (55 to 75^{o} F) for layer in tropical climate. The eggshell is made up of Calcium carbonate and is formed in the shell gland. An adequate supply of calcium and carbonate ions is required at the shell glands for better shell formation. The source of carbonates ion for shell calcification is metabolic carbon dioxide. A zinc dependent, carbonic anhydrase converts carbon dioxide and water to bicarbonate ion. Higher environmental temperature is detrimental to the shell quality in several ways.

- Panting results in respiratory alkalosis, the carbon dioxide content of the blood first decreases and is then followed by an extra-renal elimination of bicarbonate ions to restores the blood pH making it less available for egg shell.
- High environmental temperature resulted in a lower carbonic anhydrase activity in the shell gland and kidney
- A possible important factor responsible for poor eggshell quality at higher environmental temperature is a lowered blood flow (-30- 40%) through ovarian follicles and shell gland due to peripheral vasodilatation

The ability of layer to convert vitamin D_3 to its active metabolites is reduced during heat stress

The increased water intake reduces calcium solubility.

The effects of heat stress can be reduced by several ways

Increasing the nutrient density in summer did not improve the shell

Supplementation of bicarbonate, cholecalciferol or its metabolites proved to improve the shell quality during heat stress. Supplementation of sodium bicarbonate (0.12 to 1.0%) in drinking water or (1%) in diet improves eggshell quality. However, care needs to be taken to avoid excess chlorine in the diet. A reduction of dietary chloride to the minimum requirement level may improve shell quality by increasing bicarbonate resorption by kidney. It was reported that a level of 0.2 % sodium chloride provides adequate chloride for egg production

Eggshell quality and performance of laying hens was improved by ascorbic acid (100 PPM) supplementation during heat stress.

Diseases ;

Infectious bronchitis (IB), Newcastle disease (ND), avian encephalomyelitis, egg drop syndrome (EDS-76) and chronic respiratory disease have detrimental effect on eggshell quality. Infestation with both endo and ecto parasites are also responsible for poor shell quality.

Infectious bronchitis virus (IBV) causes lesions in the magnum which secrets egg albumen. The albumen produced is more watery. The eggs of layers infected with IBV are smaller, misshapen, with weak and rough shells, longitudinal ridges and hair cracks.

Production of depigmented, thin shelled, soft shelled and or shell less eggs is a characteristic feature of EDS-76 virus. Production of shell less eggs, rather than being the failure of hens to produce the eggs at all is the reason for severe drop in egg production in the EDS-76 infected flocks. It differs in this respect from both ND and IB where the numbers of eggs produced are also drastically reduced. The internal qualities of egg remain normal in EDS-76.

Toxicity –

Aflatoxin causes severe pathological changes in liver and kidney, if these changes affect the metabolic activities of these organs, the conversion of Vit D3 into its active metabolites will be affected

Fungicides are being used as seed / grain protectants during storage: Severe drop in egg production up to 95% within 4-5 days of thiram feeding is a common feature recorded during recent times. The eggs produced during thiram toxicity are mostly defective or shell less eggs and albumen is watery in nature. Eggshell defects could be attributed to reduced absorption of calcium by thiram in the gastrointestinal tract

Water supplementation of sulphanilamide (125 or 150 mg / L) reduced the intestinal calcium absorption (16 to 22%), inhibited the secretary ability of shell gland and thereby eggshell thickness

Saline drinking water

Underground water usually contains higher concentrations of dissolved salts. The incidence of eggshell defects was up to 34% in layers receiving underground water. The plasma CO_2 concentration and pH of hens receiving the saline drinking water was reduced significantly. Eggshell quality is more sensitive to sodium chloride supplied in the drinking water rather than in the diet.

Egg proteins may help lower blood pressure, say scientists

Eggs may be beneficial in lowering blood pressure, according to research by Kaustav Majumder and Jianping Wu at the University of Alberta in Canada.

In a recent issue of the **Journal of Agricultural and Food Chemistry**, the researchers describe the identification of egg proteins that might have effects similar to ACE inhibitors, prescription drugs used to treat high blood pressure.

Majumder and Wu identified several different peptides in boiled and fried eggs that act as potent ACE inhibitors. Their research showed that enzymes in the stomach and small intestine produce these peptides from eggs. Fried eggs had the highest ACE inhibitory activity.

The scientists say, however, that it will take studies in humans to determine if the egg proteins do lower blood pressure in people.

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