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FACTORS CAUSING POOR PIGMENTATION OF BROWN-SHELLED EGGS

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INTRODUCTION

The first documented report of shell pigment loss in brown-shelled eggs was in 1944 when Steggerda and Hollander, while removing dirt from eggshells produced from a small flock of Rhode Island Red hens, made the surprising discovery that some of the brown pigment also rubbed off. This effect was even more evident when the eggs were rubbed vigorously. Most of the eggs gave up their pigment fairly easily except those possessing a glossy surface.

It is well established that no single factor is responsible for the loss of shell pigment in brown-shelled eggs. Variation in pigmentation among brown-shelled eggs is more pronounced in broiler breeders than in commercial brown egg-type layers. In flocks of broiler breeders, it is common to have a variation in eggshell pigmentation, resulting in hues ranging from dark brown to almost bleached white. This contrast occurs because genetic selection for uniform brown-colored eggs in broiler breeder flocks is of little importance compared to eggshells of commercial brown egg-type birds. Most commercial producers and university personnel serving the poultry industry understand that the loss of shell pigment from brown-shelled eggs can be caused by numerous factors. Many individuals, however, still prematurely jump to conclusions and blame shell pigment loss and variability on only a single factor. The most common scapegoat is bronchitis. Statements such as *"I know my hens had bronchitis because their shells are pale"* or *"All you have to do to determine if your hens had bronchitis is to look at their eggshell color -- if the shells are pale they had a bronchitis challenge"* are still often heard in the field. Such statements are made even without knowledge of the flock's bronchitis antibody titer, bronchitis vaccination schedule, or supporting necropsy findings.

More often than not, the cause of shell pigment loss is not bronchitis but some stressor to which the flock has been exposed. Fear, for example, is a common cause of eggshell pigment loss. It is not until all the contributing factors to pigment loss are considered that the exact reason can be identified and the problem resolved. Many times the exact cause of periodic, flock-wide pigment loss is never identified.
The purpose of this article is to identify and discuss the various factors that are known to contribute to the loss of eggshell pigment. A general review, however, of the pigments and the process involved in their deposition aids the reader in better understanding shell pigmentation problems.

EGGSHELL FORMATION AND PIGMENT DISPOSITION

Once the egg reaches the site of the reproductive tract known as the uterus (shell gland), it resides there for approximately 20 hours. During this time the shell is deposited, mostly as calcium carbonate, onto the shell membranes that envelop the albumen and yolk. As shell formation progresses in the brown egg layer, the epithelial cells lining the surface of the shell gland begin to synthesize and accumulate the pigments. The three main pigments are biliverdin-IX, its zinc chelate, and protoporphyrin-IX. The most abundant pigment in today's commercial brown-shelled eggs is protoporphyrin-IX. It is not until the final 3 to 4 hours of shell formation that the bulk of the accumulated pigment is transferred to the protein-rich, viscus fluid secretion known as the cuticle. The degree of brownness of the hen's eggshell is dependent on the quantity of pigment directly associated with the cuticle. The pigment-rich cuticle is deposited onto the eggshell at about the same time shell deposition reaches a plateau, about 90 minutes prior to oviposition. Therefore, pigment distribution is not uniform throughout the thickness of the eggshell. Even though the eggshell contains traces of pigment, its contribution to the intensity of brown color is negligible compared to that of the cuticle.

FACTORS RESPONSIBLE FOR DECREASING THE INTENSITY OF BROWN SHELL COLOR

STRESS Since the majority of the pigment is localized in the cuticle, anything that interferes with the ability of the epithelial cells in the shell gland to synthesize the cuticle will affect the intensity of eggshell pigmentation. This is especially true during the final 3 to 4 hours of shell deposition since it is during this time in the egg-laying cycle that cuticle synthesis and accumulation occur most rapidly.
Stressors in poultry flocks such as high cage density, handling, loud noises, etc., will result in the release of stress hormones, especially epinephrine. This hormone, when released into the blood, is responsible for causing a delay in oviposition and the cessation of shell gland cuticle formation. The above stressors, which result in hen nervousness and fear, can cause pale eggshells to be produced. The paleness is often the result of amorphous calcium carbonate deposited on top of a preexisting fully formed cuticle or of an incomplete cuticle caused by premature arrest of cuticle formation.

Brown-shelled birds, especially broiler breeders, housed in experimental floor pens for research purposes often become fearful each time the pen is entered for such things as egg collection, vaccination, uniformity, and frame and fleshing measurements. When this occurs, production of pale-shelled eggs should be expected, especially if the fearfulness occurs during the last 3 to 4 hours of the egg-laying cycle when the cuticle formation is interrupted. In fact, the relationship between stress and the production of pale eggs by laying hens is so great that researchers have suggested that loss of shell pigment may provide a basis for a noninvasive method of assessing stress in hens.

AGE OF THE BIRD As the brown egg-type bird ages, there is a corresponding decrease in eggshell pigment intensity. The exact reason for this is unknown. It is possibly due to the same quantity of pigment being dispersed over a larger surface area of shell as egg size increases with bird age or less pigment synthesis. As the hen ages it is normal for the tapered end of the egg to contain less pigment than the rounded end. Stress-related egg retention in the shell gland and subsequent amorphous calcium carbonate deposition on the shell surface have been identified as a major cause of pale eggs in older hens.

CHEMOTHERAPEUTIC AGENTS A rapid decline in shell pigmentation is common following the ingestion of certain drugs by the hen, such as the sulfonamides. The coccidiostat Nicarbazin, administered to hens at a dose of 5 mg per day, can result in the production of pale eggs within 24 hours. Higher doses can lead to complete depigmentation of the eggshell cuticle.

DISEASE Viral diseases, such as Newcastle and infectious bronchitis, affect egg production in poultry. These viruses have a specific affinity for the mucus membranes of the respiratory and reproductive tracts. Because the virus directly infects and damages the reproductive tract, the signs of disease are manifested indirectly in the product of the tract, the egg. Thus, total egg numbers decline and eggshells become thinner and abnormally pale and have irregular contour. Internal quality is also adversely affected (watery whites). These egg production and quality problems can persist for extended periods of time.

SUMMARY

Most eggshell pigments are located in the cuticle and outer portion of the calcified eggshell. Premature arrest of cuticle formation or release of stress-related hormones (epinephrine) will result in the production of pale brown-shelled eggs. Age of the bird, use of certain chemotherapeutic agents, and disease also can affect the intensity of pigmentation. No one factor, especially infectious bronchitis, should be diagnosed as the cause of the reduced pigmentation of eggshells until all possible differentials that may affect pigmentation have been considered.

REFERENCES

- Baird, T., S. E. Solomon, and D. R. Tedstone. 1975. Localisation and characterisation of egg shell porphyrin in several avian species. Brit. Poultry Sci . 16:201-208.
- Burley, R. W., and D. V. Vadehra, eds. 1989. The Avian Egg-Chemistry and Biology . John Wiley & Sons, Inc., New York.
- Cook, J. K. A. 1986. Pale shelled eggs can be caused by IB virus. Misset International Poultry 2:38-39.
- Hughes, B.O., and A. B. Gilbert. 1984. Induction of egg shell abnormalities in domestic fowl by administration of adrenaline. IRCS Med. Sci . 12:969-970.
- Hughes, B.O., A. B. Gilbert, and M. F. Brown. 1986. Categorisation and causes of abnormal egg shells: Relationship with stress. Brit. Poultry Sci . 27:325-337.
- Hunton, P.1992. The brown egg revolution-brown versus white: A fascinating comparison. Shaver Focus 21(2):1-2.
- Kennedy, G. Y., and H. G. Vevers. 1975. A survey of avian egg shell pigments. Comp. Biochem. & Physiol . 55B:117-123.
- Lang, M. R., and J. W. Wells. 1987. A review of eggshell pigmentation. World's Poultry Sci. J . 43(3):238-246.
- McCartney, E. 1989. Infectious bronchitis update. Poultry Health Rept. Egg Industry (August): 12-16.
- Mills, A. D., J. M. Faure, M. Picard, and M. Marche. 1987. Reflectometry of wet and dry eggs as a measure of stress in poultry. Med. Sci. Res . 15:705-706.
- Mills, A. D., M. Marche, and J. M. Faure. 1987. Extraneous eggshell calcification as a measure of stress in poultry. Brit. Poultry Sci . 28:177-181.
- Mills, A. D., Y. Nys, J. Gautron, and J. Zawadzki. 1991. Whitening of brown shelled eggs: Individual variation and relationships with age, fearfulness, oviposition interval and stress. Brit. Poultry Sci . 32:117-129.
- Nys, Y., J. Zawadzki, J. Gautron, and A. D. Mills. 1991. Whitening of brown-shelled eggs: Mineral composition of uterine fluid and rate of protoporphyrin deposition. Poultry Sci . 70:1236-1245.
- Polkinghorne, R. W. 1983. Factors affecting eggshell colour in crosses between Australorp and Rhode Island Red chickens. Aust. J. Agric. Res . 34:593-597.
- Solomon, S. E. 1992. A question of color. Shaver Focus 21(2):2-3.
- Solomon, S.E., B.O. Hughes, and A. B. Gilbert. 1987. Effect of a single injection of adrenaline on shell ultrastructure in a series of eggs from domestic hens. Brit. Poultry Sci . 28:585-588.
- Steggerda, M., and W. F. Hollander. 1944. Observations on certain shell variations of hen's eggs. Poultry Sci . 23:459-461.
- Sykes, A. H. 1959. The effect of adrenaline on oviduct motility and egg production in the fowl. Poultry Sci . 34:622-628.

FOOTNOTES

1. This document is VM94, one of a series of the Veterinary Medicine-Large Animal Clinical Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date May, 1995. Reviewed May, 2003.

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