PHYSIOLOGICAL STUDY ON EGG SHELL QUALITY IN FOWL

By

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ABSTRACT

Heba Yehia Anwar Elsayed: Phsiological Study on Egg Shell Quality in Fowl. Unpublished M.Sc. Thesis, Department of Poultry Production, Faculty of Agriculture, Ain Shams University, 2013.

This study was carried out to investigate and compare the differences in egg quality traits and mechanical properties of eggshells among three fowl species: Hyline laying hens, Japanese quails and Muscovy ducks. Then, estimated the electrophoretic prophiles of shell organic matrix proteins in three fowl species to compare these proteins between them. Eggs were collected at the peak of egg production. External and internal egg quality parameters were measured. Protein extraction was conducted by mixing 3.0 g of egg then ground to fine powder using a mortar and pestle and homogenized with 1 M Tris-HCl buffer, pH 6.8 in clean eppendorf tube and left in refrigerator overnight. Then centrifuged at 10.000 rpm for 10 min. The supernatant of each sample (contains protein extract) was kept in deep-freeze until use for electrophoretic analysis. Then boil for 5 minutes in water bath before loading in the gel**.** A volume of 80 µl of the protein extract was loaded on the gels. Control wells were loaded with standard protein marker Medium range from 14.20 KDa to 200.00 KDa .The obtained results could be summarized as follow

1- The average egg weight, egg width and egg shape index were higher in Muscovy eggs compared to chicken and quail eggs. Moreover shell percentage for egg weight was higher for ducks when compared with those of chicken and quail shells (10.2, vs. 9.5 and 8.7%, respectively). With respect to breaking

strength, it could be noticed that the breaking strength of Muscovy eggs were also significantly higher than the others fowl species.

2- The presence of common matrix components in various avian species, supporting the hypothesis of universality of their distributions, but also demonstrated some particularities which may be responsible of some modification in structural organization of the egg shell of the different species (Chickens, Japanese quails and Muscovy ducks). The analysis was focused on the 9 bands of proteins from chicken, quail and duck species when stained with Coomassie Blue. These bands which were found with overall apparent molecular weights of 166.6, 183.03, 88.2, 55.5, 19.6, 34.3, 89.3, 29.01and 16.3, kDa. The molecular weight of protein may be ovocleidin 166 ,183 about 166.183 kDa, ovotransferrin about 88 kDa, ovoalbunin about 55 kDa, ovocalyxin 34 about 34kDa, ovocalyxin-29 about 29kDa, Lysozyme about19 kDa, ovocleidin16 about 16 kDa, while osteopontin protein the molecular weight found arranged between 46-54 kDa. Because these proteins were estimated by electrophoresis, there are a lot of proteins in the same band.

3- The material properties are dependent on the inorganic and organic components of the eggshell, and how they interact with one another, whilst the structural properties are dependent on the thickness of the eggshell, as well as the distribution of shell material over the egg surface, and the size and shape of the egg. Most of the methods currently available for evaluation the mechanical properties of eggshells (stiffness and strength) cannot quantify or distinguish between the separate contributions made by the material and structural variables because of their complex inter relationships.

4- The soluble proteins of calcitic matrices modify crystal growth, and thus regulate the macroscopic structure and biomechanical properties of the resulting bioceramic. Partially purified eggshell matrix proteins inhibit calcium carbonate precipitation and alter patterns to calcite crystal growth; however, the role of individual matrix proteins is unknown.

In conclusion, this study demonstrates the superiority for egg quality and mechanical properties for eggshell traits of eggs from Muscovy ducks at the peak of laying period than those of laying hens and quail eggs. Two possible roles for eggshell-specific matrix proteins have been proposed; both reflect the protective function of the eggshell in avian reproduction: Regulation of eggshell mineralization and antimicrobial defense.

Keywords: Ducks, chickens, quails, egg shell parameters, organic matrix.

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1. INTRODUCTION

Egg quality is the more important price contributing factor in table and hatching eggs. In several countries of the Far East, duck eggs are produced and consumed in large quantities by the local population thus substituting hen eggs. In Egypt, hen eggs are the main source of table eggs. Quail and duck eggs are mainly used for hatching fertile eggs and reproduction to produce ducks (meat production). Approximately 7-8% of the total amount of the eggs is broken throughout the transfer of the eggs from the breeders to the consumers. So, especially the amount of cracked and broken eggs results in a serious economical problem both for the breeders and the dealers **(Hamilton, 1982).**

The function of the eggshell is to protect the contents of the egg from mechanical impacts and micro-bacterial invasions and to control the exchange of water and gases through the pores during the extra-uterine development of the chick embryo (**Nys et al., 1999).** In the food market, the eggshell functions as a packaging material and its good quality is crucial to consumer selection and safety. So, great care is needed to preserve it intact **(Bearkdemaeer 2006)**.

The eggshell is a bioceramic material in which the mineral (CaCO3 in the polymorphic form of calcite) is intimately associated with an organic matrix **(Nys et al., 2004).** The mineral part comprises spherulitic (mammillary cores) anchored on to the shell membranes and columnar crystal layers (palisades). The arrangement and size of crystals change across these layers **(Rodriguez-Navarro et al., 2002).** It is well established that the amount of mineral (eggshell thickness) is the main variable contributing to the mechanical properties of the shell. However, there is also evidence showing that the fabric or shell microstructure may also influence shell mechanical properties **(Rodriguez-Navarro et al., 2002; Ahmed et al., 2005 and Ahmed, 2012).**

Moreover, some of the egg quality traits have significant and direct effects on the prices of especially commercial flocks. In the egg processing enterprises, the weight of eggshell, albumen and the yolk that form the egg as well as their rates affect the amount and price of the product **(Altan et al., 1998**). During the investigations made on the quality traits of the egg, the researchers had focused on the studies related to the increasing of the stiffness of the eggshell, because the quality of the eggshell has a vital importance for the laying force, embryo growth and the chick quality. Egg weight was easily predictable from egg length and width as positive association among these traits existed **(Farooq et al., 2001).** Information on egg weight along with egg width and length will further open the domain for trying out various prediction equations in order to predict eggshell weight and shell thickness **(Khurshid et al., 2003).**

Biochemical studies have shown that the eggshell matrix, about 2% of the total eggshell by weight, is predominantly proteins (70%) and polysaccharides(11%). The soluble matrix components of the eggshell have been studied (**Dunnet al., 2007**), but without separating the eggshell matrix into the components arising from the mammillary and palisade layers. Therefore, it remains to be established how the proteins of the palisade and mammillary layers compare, a number of roles have been proposed for proteins which constitute the organic matrix in biominerals.

The organic material may modify the crystallization of mineral, either by presenting nucleation sites (epitaxy) or by inhibit in growth on certain crystal planes **(Wheeler and Sikes, 1989)**. Alternatively, proteins may influence the mechanical properties of the shell by forming a reinforcing fibrous network which pervades the mineral, as in the palisade layer of the fowl's eggshell (**Silyn-Roberts and Sharp, 1986**).

The purpose of this study was to compare the protein species composing the eggshell matrix in different parts of the shell by SDS-PAGE and chromatography, in order to characterize the protein constituents of the mammillary knob and palisade

layers, and to distinguish differences which might relate to their function.

Thus, the aim of this study is to give some insight into the mechanical properties and organic matrix of eggshells for the three fowl species: Hyline laying hens, Japanese quails and Muscovy ducks.

2- REVIEW OF LITERATURE

2.1. Egg quality measurements

Egg is a biological structure intended by nature for reproduction. It protects and provides complete diets for the developing embryo and serves as the principal source of food for the first few days of the chick's life. It has been observed in the poultry breeding that the quails were benefited as much as hens both for their meat and eggs, therefore, commercial quail, chicken and duck breeding have become widespread **(Nys et al., 2004).** Moreover, some of the egg quality traits have significant and direct effects on the prices of especially commercial flocks. In the egg processing enterprises, the weight of eggshell, albumen and the yolk that form the egg as well as their rates affect the amount and price of the product **(Altan et al., 1998).** During the investigations made on the quality traits of the egg, the researchers had focused on the studies related to the increasing of the stiffness of the eggshell, because the quality of the eggshell has a vital importance for the laying force, embryo growth and the chick quality.

The productivity and quality of the breeding eggs had an overall significance or the continuity of the flocks and for an economical breeding **(Sogut et al., 2001)**

2.1.1 External egg quality

2.1.1.1. Egg weight and dimension

Egg weight was easily predictable from egg length and width as positive association among these traits existed **(Farooq *et al*., 2001)**. Information on egg weight along with egg width and length will further open the domain for trying out various prediction equations in order to predict eggshell weight **(Khurshidet *et al*., 2003).**