New insights on eggshell mineralization and how they can contribute to maintain shell quality

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Picture of the first author

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Biography

I am research director in INRAe (National Research Institute for Agriculture, Food and Environment) in France. I am Scientist at the Avian Biology & Poultry Research unit (UMR-BOA) in collaboration with the University of Tours. UMR BOA conducts integrated research on the biology of birds, from the molecular level to that of the animal in its environment. Its objective is to produce knowledge in the fields of physiology and genetics and to contribute to the development of sustainable livestock systems. I am co-head of the "Egg defences, valorisation, evolution" team. My research focuses on biochemistry and molecular biology related to the formation of eggs and their qualities. I have worked on eggshell formation and the identification of proteins in the organic matrix of the eggshell, involved in the calcification process and have coordinated several national and international research programs. My research also focuses on high-throughput methodologies used to identify and characterize biological activities related to the natural defences of eggs. I have published more than 70 papers in international scientific journals, 12 book chapters, and have been invited to present my results at more than 30 congresses and I have about 120 conference papers.

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Abstract

The eggshell is a critical barrier against mechanical stresses, dehydration and microbial penetration. Its integrity is essential to maintain the hygienic quality of this basic human food and to limit the number of downgraded eggs. In such a context, we are looking for eggshell strength specific markers in order to optimize egg quality.
The eggshell is made of 95% mineral phase (calcium carbonate in calcite form) and an organic matrix (3.5%) mostly containing proteins. Eggshell formation arises from an extra-cellular biomineralization process occurring in the uterus, in a fluid that contains eggshell precursors and involves a transient phase of amorphous calcium carbonate (ACC). Shell mineralization requires a large and continuous supply of calcium that comes in part from the diet and in part from the skeleton (medullary bone). Medullary bone serves as a calcium reservoir for eggshell calcification during the night and its resorption and formation synchronized with eggshell formation.
In this review, we will describe both mineral supply and biomineralization mechanisms. We will focus

on recent knowledges on vesicular transport to stabilize ACC and to address it to the mineralization site. This model of calcification using vesicles to stabilize ACC, explained the fast deposition of the crystalline calcite-oriented layer in the shell.

The proteins described are currently further explored as biological markers. Their abundances relative to the quality of shell, age of birds (long laying cycles) and vitaminic status are explored. Genes coding these proteins are currently mapped on chicken genome for a selection of chicken layers with improved mechanical properties.