| | | | |
|---|---|---|---|
| Early Stage Researcher (PhD Year 1) | X | Post-Doctoral Researcher/Senior Researcher/PI | |
| Entry for the Engineers Ireland Biomedical Research Medal | | Corresponding author has completed PhD and would like to review BinI abstract submissions | |

Please place an X in any appropriate categories

# THE IMPACT EFFECT OF TRACE MINERAL FORM ON THE BIOMECHANICAL PROPERTIES OF EGGSHELL

**McManus, L.[1], O'Connell, B .[1] Murphy, R. [3] Clarkin, O.M. .[1]**
[1]MedEng Centre, School of Mechanical engineering, Dublin City University
[1]Nano-Bioanalytical Research Facility, Dublin City University
[3] Alltech European Bioscience Centre, Ireland
*email: leah.mcmanus8@mail.dcu.ie*

## INTRODUCTION

The objective of this research is to examine the effect of trace mineral forms on the mechanical properties of hen eggshell. Trace mineral dietary supplementation has been confirmed to influence eggshell quality. Minerals such as zinc, manganese, copper, magnesium and selenium are important in eggshell formation and are routinely incorporated into hen feed[1]. Research has shown that by chelating inorganic trace elements with an organic bonding group, such as a peptide, trace mineral bioavailability can be enhanced[2,3]. The increase in absorption that organic trace minerals (OTMs) may provide could influence eggshell properties.

As hens age, their eggs become larger and shells become thinner, ultimately an undesirable development for egg longevity[4]. This outcome has proven hard to combat and OTMs may aid in this problem by influencing the eggshell ultrastructure; potentially strengthening eggs.

Eggshell material properties have been a major obstacle for the poultry industry to tackle. 7-10% of eggs produced for consumption are discarded due to defects from handling[5]. Weaker eggshells are prone to develop defects, which increases the risk of bacterial penetration through the shell. This is a financial drain on the industry, along with contributing to the increasing problem of global waste and foodborne infections. Developing measures to increase the strength of eggshells may be beneficial to this endless conundrum.

## MATERIALS AND METHODS

Two groups of aged matched (33 weeks) Lohman Lite hens were used. One group were supplemented with OTMs (Bioplex®) from 20 weeks of age. The other group were supplemented with inorganic trace minerals.

Nanoindentation was used to assess hardness and elastic modulus within the shell. Scanning electron microscopy (SEM) and atomic force microscopy (AFM) was used to observe shell ultrastructure. Further analysis of fracture toughness[7] in compression was assessed by creating a biaxial stress state in a pre-notched egg sample.

## RESULTS

Figure 1&2 depict the SEM and Nanoindentation data from eggshells of hens fed OTM and inorganic dietary supplement.

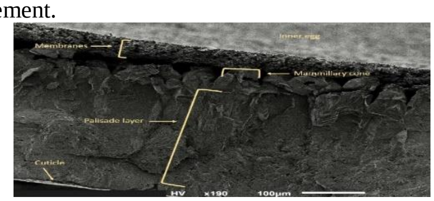


**Figure 1.** SEM images of eggshell on OTM diet.

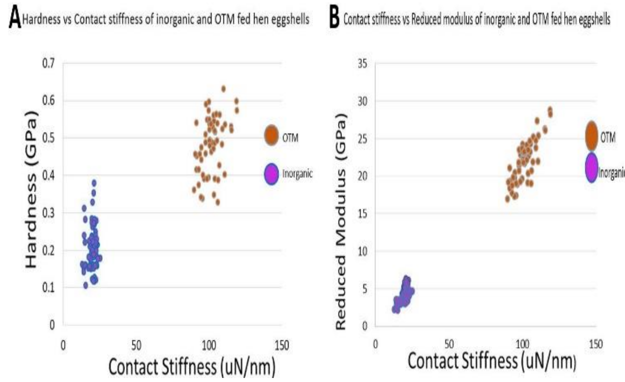


**Figure 2**. Nanoindentation data obtained. A. Hardness against contact stiffness. B. Reduced modulus against contact stiffness.

**Figure 1.** shows the transverse section of OTM supplement eggshell. The structure and layers are seen. **Figure 2.** Indicates the OTM diet appears to have a clear effect on the mechanical properties of hen egg shells, increasing both the hardness and reduced modulus at the nano-scale.

## DISCUSSION

This preliminary research has demonstrated that trace mineral form can influence egg shell properties. The data collected shows an obvious difference in the properties of eggs produced through dietary supplementation with OTM and inorganic minerals. These initial nanoindentation studies demonstrate the impact OTMs have on physical eggshell characteristics such as hardness and contact stiffness.

Further research in this area may provide more in-depth information on the beneficial impacts that may accrue following OTM supplementation. Fracture toughness studies may provide knowledge on OTM influences within the shell. Although hardness and reduced modulus were impacted, the eggshell's ability to resist fracture may not. Therefore, additional testing should occur on the influence the OTM diet has on eggshell properties, for a comprehensive understanding to be generated.

## REFERENCES

[1]Nys, 13th European Symposium Poultry Nutrition, Blankenberge, Belgium, 2001.
[2]Zamani et al., Pakistan Journal of Biol Sci 8, 1311-1317, 2005.
[3]Stefanello et al., Poultry Science 93, 104-113, 2014.
[4]Roberts, Journal of Poultry Science 41, 161-177, 2004.
[5]Macleod et al., Inter. Journal of Fracture 142, 29-41, 2006.
[6]Bai et al., Annals of Animal Science 17, 503-515, 2017.
[7] Taylor et al., Acta Biomaterialia 37, 42-49, 2016.