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Study of bone architecture and the organic matrix-mineral interface at micro and nanoscale

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The complex interactions between an organic matrix (primarily collagen type I) and a mineral phase (carbonated apatite nanocrystals) contribute to the exceptional mechanical properties (strength and resilience) of bone tissue [1]. To better understand bone structure and the relationship between its different components, a multiapproach investigation at the micro and nanoscale is needed. State-of-the-art techniques such as micro X-ray Computed Tomography (µ-CT), scanning and transmission electron microscopy (SEM-TEM), and synchrotron-based techniques (e.g., synchrotron FTIR spectroscopic analysis (SR-FTIR)) have proven to be exceptional tools for unveiling structural and compositional heterogeneity of bone tissue characteristics [2]. This biomaterial is a dynamic hierarchical nanocomposite whose remodelling is controlled by specialized cells, and it is affected by biological and physiological changes of the living organism [3]. Among the many factors that affect bone quality, age is perhaps the most evident and concerning.

The present study investigates the most suitable protocols for bone characterization at the micro and nanoscale to better understand age-related changes in bone tissue of laying hens, which are a very interesting model for the development of bone pathologies. To this end, tibia samples from pre-laying 17-weeks-old pullets to 90-weeks-old laying hens individuals were selected. The physiological stress caused by repeated bone remodelling cycles to meet the high calcium demands for eggshell biosynthesis increases the susceptibility of laying hens to bone deterioration toward the end of the egg-laying cycle. The use of high-resolution techniques (µ-CT, SEM, TEM, SR-FTIR) for bone tissue imaging and chemical analyses provides insight into structural and compositional changes that may contribute to the decline in bone quality in aging laying hens.

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