Molecular insights into the stiffening mechanism of Chondrosia reniformis: an omics-based approach

Miguel Rocha*†[1,2], Sofía Blanco[3,4], Rui Reis[1,2], Tiago Silva[1,2], and Ángel Diz[3,4]

[1]3B's Research Group, I3Bs – Research Institute on Biomaterials, Biodegradables and Biomimetics, University of Minho – Portugal

[2]ICVS/3B´s – PT Government Associate Laboratory, Braga/Guimarães, Portugal – Portugal

[3]Centro de Investigación Mariña da Universidade de Vigo (CIM-UVigo), Vigo, Galicia, España – Spain

[4]Department of Biochemistry, Genetics and Immunology, University of Vigo, Vigo, Spain – Spain

Abstract

Chondrosia reniformis shows remarkable plasticity, rapidly and reversibly stiffening its body in response to mechanical stimulation. This ability is linked to dynamic collagenous tissues (DCT), in which changes in interactions between collagen fibrils and possibly other ECM components occur. However, this phenomenon is scarcely addressed, and no stiffening factors have been identified. Notably, echinoderms possess mutable collagenous tissues that share similarities with DCT, with several identified factors involved in their tissue mutability. This study investigates the molecular mechanisms of *C. reniformis* stiffening using RNA-seq and proteomics to identify differentially expressed genes and proteins between stiffened and compliant states. It also explores associated functional pathways, potential homologies with echinoderm stiffening factors, and candidate leads unique to *C. reniformis*.

A comprehensive transcriptome assembly and annotation was performed and the differential expression analysis revealed that over 20% of genes were modulated. Functional enrichment analysis linked stiffening to a stress-induced defense mechanism and suggested a possible role for symbionts. Proteomics showed major shifts in protein abundance, identifying mechanotransducers as sensors of mechanical stimuli. Remarkably, both transcriptomic and proteomic data pointed to parallels with vertebrate actin–myosin muscle contraction, hinting at a shared evolutionary origin. No echinoderm stiffening homologs were found, indicating *C. reniformis* uses distinct molecular mechanisms for tissue stiffness regulation.
This study reveals a mechanism driven by multiple interconnected factors, offering insights into the molecular mechanisms of *C. reniformis* stiffening. From a biotechnological standpoint, these findings pave the way for the development of novel enzymatic collagen crosslinkers inspired by *C. reniformis* stiffening mechanism.

Keywords: dynamic collagenous tissues, differential expression analysis, differential protein abundance analysis, muscle contraction

*Speaker

†Corresponding author: miguel.rocha@i3bs.uminho.pt