Bioinspired Nanocomposites of Resilin with Cellulose Whiskers

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Introduction

Resilin is a polymeric rubber-like protein secreted by insects to specialized cuticle regions, in areas where high resilience and low stiffness are required. Resilin binds to the cuticle polysaccharide chitin via a chitin binding domain and is further polymerized through oxidation of the tyrosine residues resulting in the formation of dityrosine bridges and assembly of a high-performance protein-carbohydrate composite material. [1]. Plant cell walls are protein-polysaccharide composites exhibit extraordinary strength exemplified by their ability to carry the huge mass of some forest trees. Inspired by the remarkable mechanical properties of insect cuticles and plant cell walls **we hypnotized that novel composites of resilin and cellulose will display useful mechanical properties combining strength and elasticity.**

Materials and Methods

Recombinant resilin fused to cellulose binding domain (CBD) was expressed and purified from *E. coli.* Cellulose whiskers (CW) were prepared by controlled H_2SO_4 hydrolysis of micro crystalline cellulose followed by repeated washing cycles with H_2O and sonication resulting in honey like liquid crystal suspensions. CW suspensions were subsequently cast into aluminum molds and lyophilized resulting in stiff and plastic highly porous sponges (Fig. 1A). Resilin-CBD solutions were embedded into the sponges and polymerized either by $[Ru(bpy)_3]^{2+}$/ammonium per-sulfate system or by Fe/H_2O_2 photo-Fenton system that we have recently adopted for this protein.

Results

Composite sponges of resilin and CW resulted in dramatic alteration in mechanical behavior including high elasticity, resilience and resistance to repeated cycles of mechanical stress (Fig. 1B). In addition we report for the first time successful resilin polymerization by photo-Fenton reaction resulting in elastic, rubber-like, hydrogels (Fig. 2)

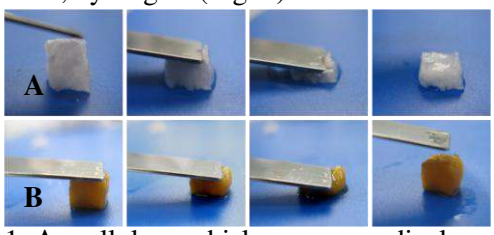

Fig. 1. **A;** cellulose whiskers sponge displays high plastic deformation, low elasticity and resilience. **B;** highly elastic composite resilin-CBD/CW sponge

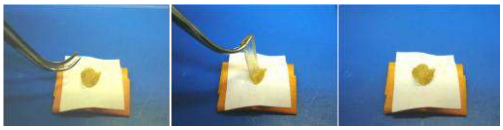

Fig. 2. Novel resilin elastic hydrogel polymerized by photo-Fenton system

Discussion and Conclusions

Tendons, ligaments and spine related diseases are among the most common health problems in the world adult populations. In spite some impressive advances that were made, regeneration if these tissues currently lack suitable scaffolds due to the high mechanical strength and durability that is required yet to be achieved. Resilin-CBD and cellulose nano-composite systems display high strength and elasticity therefore potentially will be able to support regeneration of these challenging tissues.

References

1. Qin G *et al,* (2009) *Biomacromolecules,* **[Epub ahead of print]**

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Disclosures

Include commercial conflict of interest disclosure information here, or a statement that authors have nothing to disclose.