Modulating Fibroin Self-Assembly in Green Consolidants for Fragile Silk Artifacts

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Silk artifacts possess immense cultural and artistic significance but are highly vulnerable to degradation processes that alter the secondary structure of fibroin, the main structural protein of silk, leading to a progressive loss of mechanical performance. Effective and compatible consolidants for historic silk artifacts remain lacking with need for improved and reliable materials to preserve and transfer this heritage. To fill this gap, we developed consolidation formulations based on self-regenerated silk fibroin (SRSF) derived from waste silk, combining conservation requirements with sustainable material sourcing. In particular, hybrid formulations composed of SRSF and cellulose nanocrystals (SRSF-CNC) demonstrated enhanced consolidation efficiency when applied to artificially aged silk fibers [1][2]. However, while the incorporation of CNCs improves mechanical reinforcement, it also accelerates fibroin self-assembly, resulting in reduced formulation stability and limited shelf life. To overcome this limitation, we designed sustainable SRSF and SRSF-CNC formulations incorporating bio-derived additives, L-arginine and sericin, with the aim of regulating fibroin self-assembly and improving dispersion stability. Their self-assembly behavior and effectiveness as consolidants for aged silk fibers in the presence of the bio-derived additives were investigated using complementary physicochemical characterization techniques. In addition, application tests on historical textiles were conducted in collaboration with the Metropolitan Museum of Art (MET, New York). The results indicate that both L-arginine and sericin effectively modulate fibroin self-assembly without compromising consolidation efficacy, while preserving the visual appearance of silk artifacts. Overall, this work proposes a sustainable and adaptable approach to silk consolidation based on colloids and soft matter, contributing to the development of innovative conservation materials within a circular economy framework, and offering new perspectives for the long-term preservation of historical textile collections.

Keywords:
Self-regenerated silk fibroin , Self-assembly, Textile consolidation, Cultural heritage preservation

References:

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