Silkworm Gut Fibers as a Novel Biomaterial for Tissue Engineering Applications

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Introduction

Silk fibroin has been largely studied in tissue engineering due to its excellent physical and biological properties. Based on this regard, we have developed a new biomaterial consisting on high performance fibers produced directly from the silk glands of silkworms (*Bombyx mori*) called silkworm gut fibers (1). This novel biomaterial could be a potential solution in tendon and ligament repair, as these are very common injuries and the traditional surgical reconstruction including auto/allograft and ligament prostheses implants can involve several complications. With this aim, we have braided the silkworm gut fibers, in order to explore the possibility to create a consistent scaffold for ligament repair.

Methods

The production of the silkworm gut fibers is based on a traditional procedure that consists of immersion the silk glands in an acidic solution and a subsequent stretching. We evaluated the mechanical properties of 3 silkworm gut fibers weaved in three-strand braids. The biocompatibility assay was also performed by seeding bone marrow adult human mesenchymal stem cells (*ah*MSCs) on the braided material. 7, 14 and 21 days after seeding, adhesion and proliferation of the cells were studied by SEM and MTT assay, respectively.

Conclusion

We conclude that silkworm gut fibers combine good mechanical and biological characteristics to be considered a potential biomaterial in tissue engineering applications.

Results

Our results showed a good and remarkable mechanical strength, with Young's modulus values of 80 ± 20 MPa and an ultimate strength of 18 ± 2 MPa.

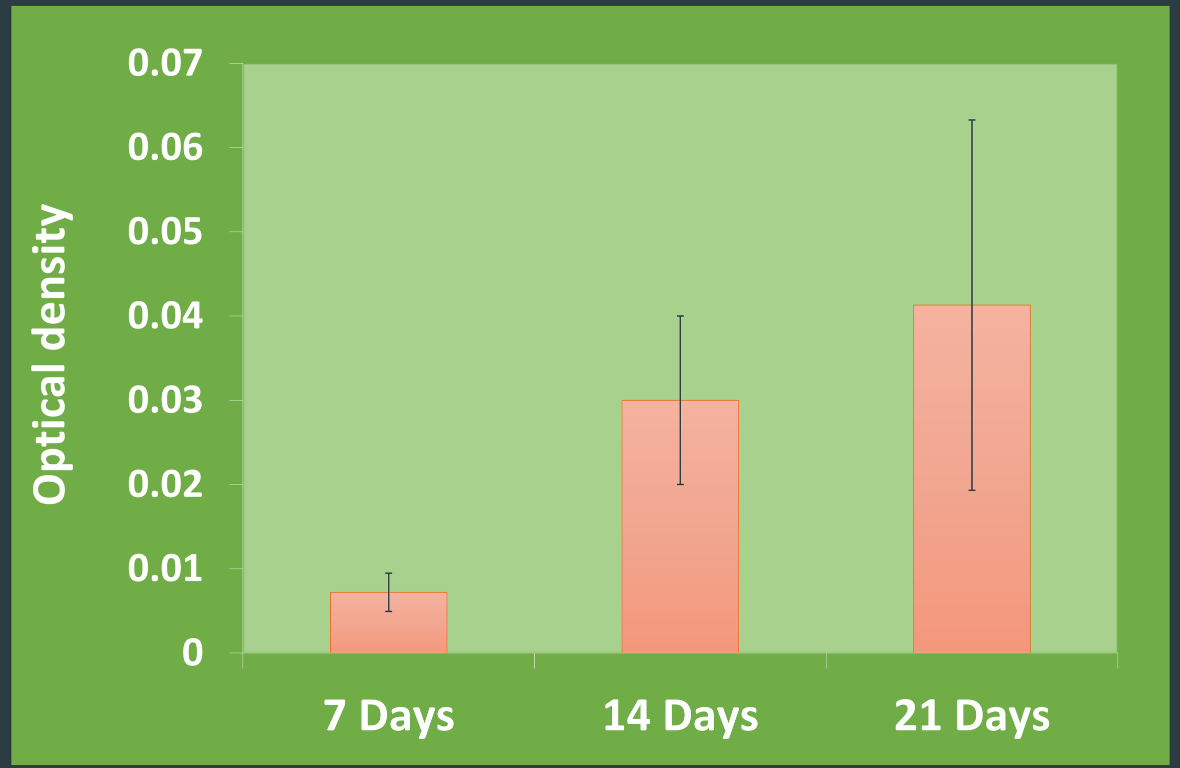

Figure 2. SEM micrographs of *ah*MSCs growing on the braided silkworm guts at the different points of the study and at different magnifications.

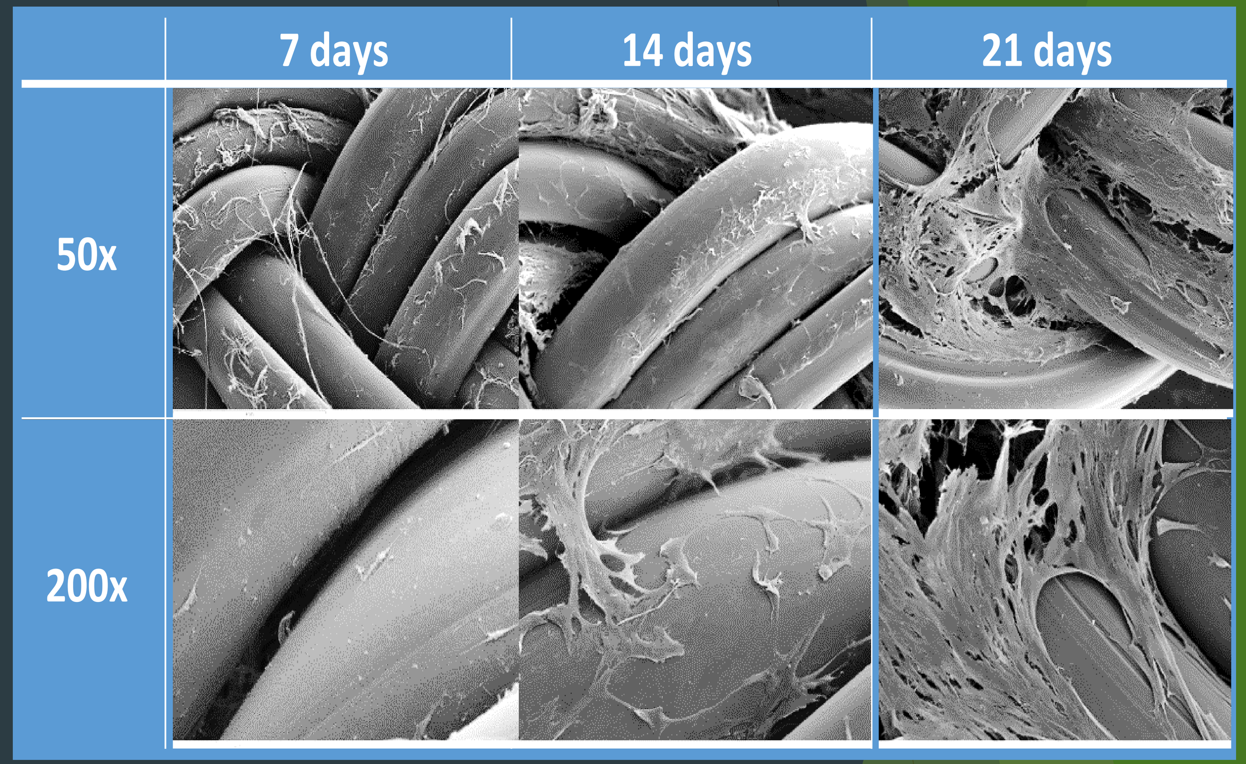

Figure 1. SEM micrographs of *ah*MSCs growing on the braided silkworm guts at the different points of the study and at different magnifications.

Moreover, cell adhesion and proliferation were excellent, the cells appeared well spread and attached to the silkworm gut fibers surface, connecting to neighbouring cells and organizing a monolayer over the braided material at day 21 post-seeding (Figure 1 and 2).

Acknowledgments

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Biography

Ana Pagán obtained the degree in Biology from University of Murcia. She has completed her PhD from the same University at the age of 28 years, with a research stay at the Division of Nutrition and Metabolic Diseases, LMU University, Munich, Germany. She works as a postdoctoral researcher in the Instituto Murciano de Investigación y Desarrollo Agrario y Alimentario (IMIDA, Murcia, Spain), in the Department of Biotechnology, with premier biomaterials in tissue engineering.

Recent Publications

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2. Lozano-Pérez AA, *et al.* (2017) Silk fibroin nanoparticles: Efficient vehicles for the natural antioxidant quercetin. Int J Pharm. 25;518(1-2):11-19.
3. Paredes JI, *et al.* (2016) Impact of Covalent Functionalization on the Aqueous Processability, Catalytic Activity, and Biocompatibility of Chemically Exfoliated MoS2 Nanosheets. ACS Appl Mater Interfaces.
4. Munuera JM, *et al.* (2015) High quality, low oxygen content and biocompatible graphene nanosheets obtained by anodic exfoliation of different graphite types. Carbon 94: 729-39.
5. Ayán-Varela M, *et al.* (2015) Investigating the Dispersion Behavior in Solvents, Biocompatibility, and Use as Support for Highly Efficient Metal Catalysts of Exfoliated Graphitic Carbon Nitride. ACS Appl Mater Interfaces. 4;7(43):24032-45.
6. Aznar-Cervantes S, *et al.* (2017) Electrospun silk fibroin scaffolds coated with reduced graphene promote neurite outgrowth of PC-12 cells under electrical stimulation. Mater Sci Eng C (under revision).