Cellulose-in-cellulose 3D-printed hydrogels and aerogels for soft tissue engineering

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Introduction

Bacterial cellulose is one of the cellulose derivatives with the greatest purity and porosity, so it has sparked interest in the regenerative medicine field [1]. Nevertheless, the addition of bacterial cellulose nanofibers modifies the rheological properties of 3D printing inks so certain applications of nanocellulose as part of 3D-printed gels have barely been explored.

Methodology

In this work, bacterial cellulose nanofibers are obtained through a well-established protocol from the bacterial strain *K. xylinus* [1 - 3] and were added into methylcellulose inks to manufacture 3D-printed hydrogels and aerogels. Polyurea crosslinking was explored as a method to enhance the performance of the cellulose-in-cellulose gels. Scanning and transmission electron microscopies as well as printing fidelity measurements were employed to characterize the gels. Cell studies and hemolytic activity tests were conducted to ensure the absence of toxicity of the formulations.

Results and Discussion

Bacterial cellulose nanofibers were obtained with a diameter close to 50 nm and were incorporated into methylcellulose inks, with shear-thinning properties adequate for 3D printing. Nanocellulose adding into gels decreased their volume shrinkage and increased their printing fidelity. Polyurea crosslinking yielded biocompatible gels with enhanced structural properties. Results obtained encouraged future research of these gels as soft tissue grafts.

Conclusions

Bacterial cellulose nanofibers were incorporated into 3D-printed methylcellulose hydrogels and aerogels, yielding structures with morphological properties suitable for soft tissue engineering. The polyurea crosslinking of the cellulose-in-cellulose gels enhanced their physicochemical performance resulting in promising formulations for regenerative medicine.

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