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Preparation of 3D nanofibrous material of natural polymers and its mechanical properties

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1. Introduction

Hydrogel are widely used for medical application due to their outstanding properties such as biocompatibility, good swelling behavior and stimuli-responsive characteristic. Chitosan and silk fibroin are natural material with nontoxicity and biodegradability, promoting the cell attachment and proliferation. The biocompatibility of fibroin and chitosan composite is reported to use for membrane such as filter material, tissue engineering and biosensor. In this study, various concentration of fibroin nanofiber containing chitosan in hydrogel/alcogel was prepared by neutralization and solvent exchange method. Their mechanical properties, bioactivity and stability were investigated. The resulted fibroin nanofiber and chitosan composite could be applied for wound dressing and drug delivery.

2. Experimental

Coarsely crushed cocoon (Bombyx mori, Nagasuna cocoon Co., Ltd.) was used as raw material after removed sericin. The 1 wt.% fibroin fibers/water was ground to prepare the fibroin nanofiber (100-400 nm size) solution [1].

The hydrogels containing FNF and chitosan (Wako Pure Chemicals, DDA: 80%) were prepared as followed. 0%, 0.2%, 0.4% and 0.6% (w/w) fibroin nanofibers in water slurries were used. FNF/water slurries were mixed with 4g of chitosan (CS) and 4g of acetic acid by a shaking water bath. The FNF/CS dispersions were prepared using ultrasonic homogenizer and poured into each petri dish after degassed. Then, FNF/CS hydrogels was formed by neutralization method. The obtain hydrogels were washed with distilled waters until neutral before storing. Solvent exchange method was applied to prepare the FNF/CS alcogel.

3. Results and discussion

The 0%, 0.2%, 0.4%, and 0.6% (w/w) fibroin nanofiber/ chitosan hydrogels/ alcogels were used to measure their mechanical properties, bioactivity tests, and stability.

The results showed that the amount of FNF concentration in FNF/CS hydrogel was linear with the increase of compressive modulus. Besides, the FNF/CS alcogels showed higher compressive strengths than their hydrogels. In previous reports, the higher concentration of FNF in FNF/CS hydrogels increased their stabilities due to the variation of pore size structures [2,3]. The pore size of hydrogels could relate to the amount of hydrogen-bonding/ electrostatic interaction inside their gel structures. Ethanol solvent may increase hydrogen bond and Van der Walls interactions between the FNF and CS components in their alcogels. In conclusion, variation of FNF concentration in FNF/CS hydrogels/alcogel was possible to control their stabilities and their mechanical properties.

Furthermore, FNF/CS hydrogel could be a potential materials to use for medical applications. Bioactivity tests included biological studies, drug loading, swelling behavior, and in vitro degradation study were conducted. The bioactivity of 0%, 0.2%, 0.4% and 0.6% (w/w) fibroin nanofiber/ chitosan hydrogels are discussed.

References

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