Improved mechanical performance of gelatin film by mesh design of cellulose-reinforced caseinate-alginate edible ink

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Background

- Cold fish gelatin (FG) can be used to develop edible packaging; however, FG film has a relatively poor mechanical strength, hindering its usage as a packaging material.
- Edible additives (e.g. cellulose medium fibers (CF) and cellulose nanofibers (CNF)) can be incorporated into FG films by mesh design to improve the mechanical strength (**Fig 1**).
- Research shows shear-induced alignment of cellulose in edible ink can result in 3D-printed objects with enhanced mechanical properties in the longitudinal direction[1].
- Geometric configuration of the 3D-printed mesh of cellulose-reinforced caseinate-alginate printable ink can affect the structural properties of the obtained FG films.

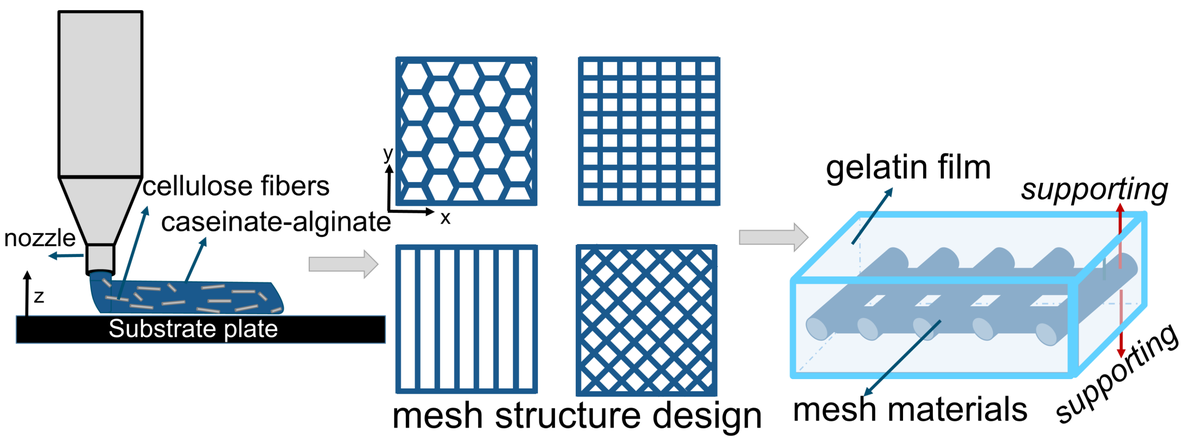

Figure 1. Illustration of mesh design and mesh supporting in gelatin film.

Objective

To investigate the influence of mesh design of cellulose-reinforced edible ink on the mechanical properties of gelatin film.

Shear induced alignment of cellulose fibers (CLSM)

Most CF were aligned in the extrusion direction in the single filament by 3D printing (**Fig 2)**.

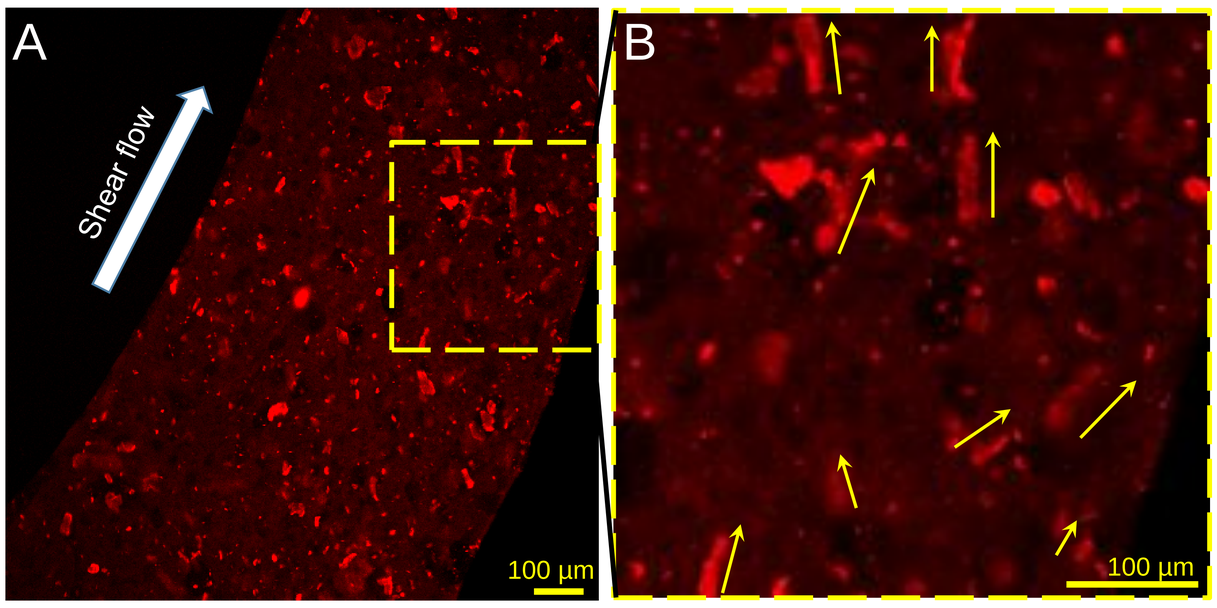

Figure 2. CLSM images of extruded filament of caseinate-alginate ink containing cellulose medium fibers (CF). A: the single filament with 15 wt% caseinate, 1.5 wt% alginate, and 1.5 wt% CF, white arrow represents the shear flow direction (scale bar :100 μm); B: partial enlarged view, yellow arrows represent the alignment direction of CF (scale bar :100 μm).

Approach

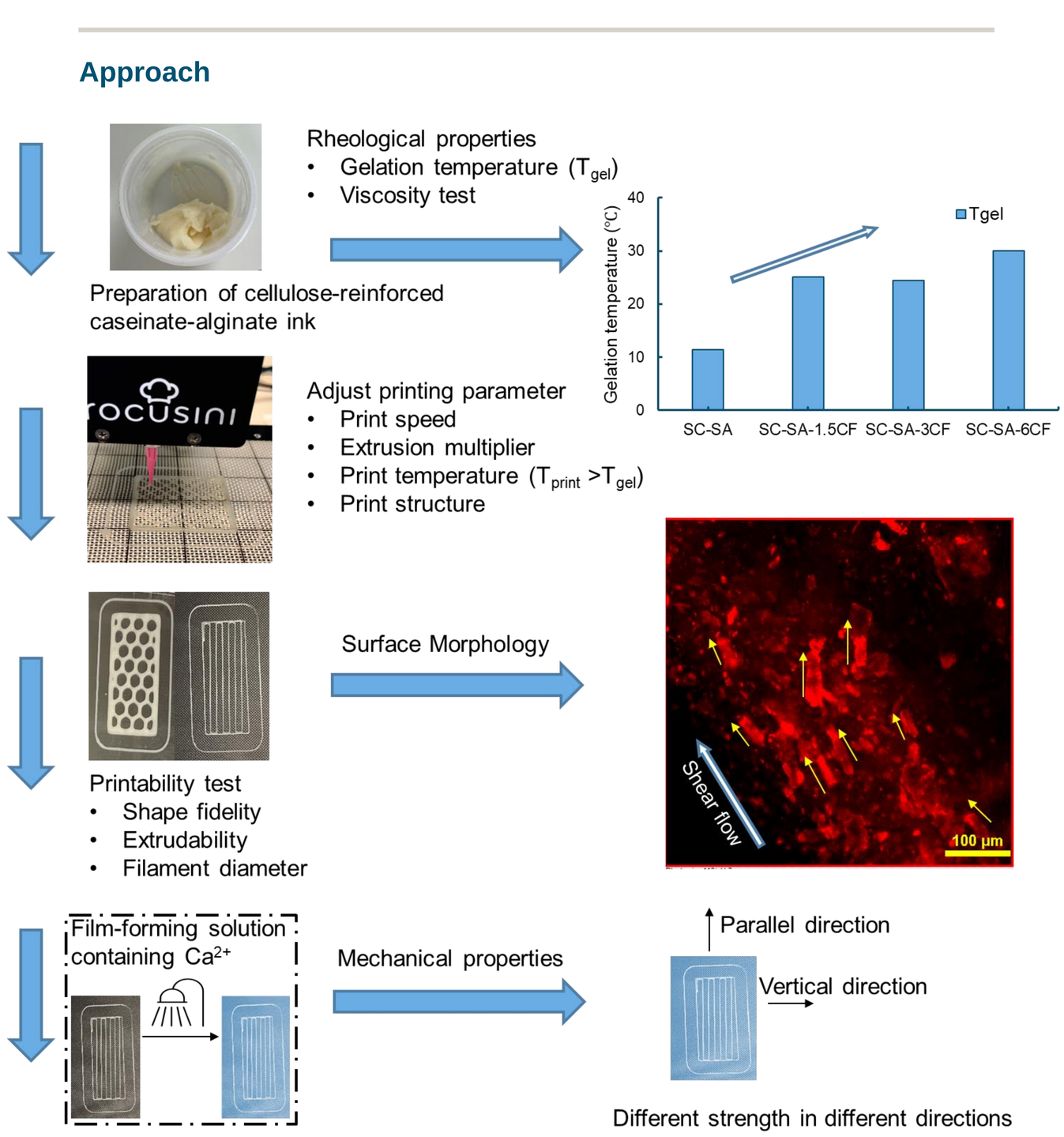

Figure 3. Experimental workflow ($CaCl_2$ is added to the gelatin film-forming solution to maintain the original printed structure of the mesh by cross linking with alginate).

Summary

- CF could be aligned in the filament in the extrusion direction.
- The addition of CF increased the T_{gel} of caseinate-alginate ink (T_{gel} > 24℃), and the ink containing CF could be printed at room temperature.

Hypothesis

- Different sized cellulose (CF/CNF) could provide different mechanical supporting strength.
- Different geometric configuration of mesh had different strength in paraller and vertical directions.

Acknowledgements

This work was supported by the NWO Sectorplan Techniek and the Chinese Scholarship Council (CSC). Lu Zhang for guidance. Maurice Strubel, Jos Sewalt, Jarno Gieteling, Lyneth Duipmans, Martin de Wit, and Wouter de Groot for technical support. Yizhou Ma, Yifeng Lu, and Ruihao Zhu at WUR for sharing ideas and discussions.

Reference

1. Wang, Q., Sun, J., Yao, Q., Ji, C., Liu, J., & Zhu, Q. (2018). 3D printing with cellulose materials. Cellulose, 25. https://doi.org/10.1007/s10570-018-1888-y.

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