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Assessing printability of semi-solid extrusion 3D printing systems: The impact of Avicel concentration

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The increasing need for patient-specific dosing emphasizes the importance of flexible drug delivery systems tailored to individual therapeutic needs. In this context, the aim of this study was to fabricate 3D-printed tablets using cefixime as a model drug and to investigate the effect of Avicel PH102 concentration on the rheological properties, printability, and mechanical stability of the printed tablets. Accordingly, cefixime and Avicel PH102 were first geometrically mixed as dry powders and subsequently incorporated into previously prepared Poloxamer 407 (P407) hydrogel. Concentrations of P407 and cefixime were fixed at 20% (w/w), while the Avicel PH102 content was set at 0.9%, 2% and 4% (w/w). Rheological characterization was conducted using oscillatory amplitude sweep and three-interval thixotropy tests, while printability was assessed on a semi-solid extrusion 3D bioprinter through filament formation and layer adhesion experiments. Cylindrical tablets were printed and dried at room temperature, followed by measurement of mass and dimensional parameters to assess shape retention. All formulations exhibited gel-like behavior with shear-thinning properties and structural recovery after high shear. The 2% Avicel formulation produced the longest filaments and the most consistent tablet dimensions after drying, reflecting an optimal balance between flow during extrusion and structural recovery. At the intermediate Avicel PH102 concentration, elastic strength, thixotropic recovery, and extrusion stability were more favorable than in 0.9% and 4% formulations, allowing consistent layer stacking and dimensional fidelity. These results highlight the importance of excipient concentration in SSE 3D printing and indicate that an appropriate Avicel PH102 content contributes to consistent tablet stability and reproducibility, critical for individualized therapy.

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