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Abstract

PERaME: Personalised polypills with programmable release made by 3D printing

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Additive manufacturing enables the production of personalised, programmable-release polypills, which may help address polypharmacy and poor medication adherence [1]. However, this requires feedstock materials that can meet printability requirements, dosing accuracy, and tailored dissolution behaviour simultaneously. The PERaME (Personalised Adaptive Medicine) project aims to develop feedstock filaments for 3D printing capsule shells filled with powder drug formulations for patient-specific oral delivery.

This work aimed to evaluate how capsule shell geometry, specifically wall thickness, diameter, and layer height, governs dissolution behaviour using hypromellose acetate succinate (HPMCAS) as the model enteric filament material. HPMCAS was selected for its pH-dependent solubility, offering protection of acid-labile drugs and enabling site-specific intestinal release.

HPMCAS-based filaments were fabricated by hot melt extrusion at three plasticiser loadings and characterised for thermal, mechanical, and feedability properties. A purpose-built texture analyser method was developed to quantify filament feedability by replicating the axial compressive loading experienced during printer feeding, identifying formulations that are either too brittle or too soft for consistent extrusion [2]. Of the three formulations tested, the formulation containing 20 wt% plasticiser demonstrated the most favourable thermal property and feedability. Dual-compartment capsule shell geometries were generated using FullControl GCode Designer [3] and printed from this filament. Fluorescein sodium salt powder was manually filled into the partially printed shell, followed by sealing the contents. Sequential pH dissolution testing (HCl pH 1.2 followed by PBS pH 6.8) confirmed pH-dependent drug release behaviour *in vitro*.

Wall thickness was the main geometric factor governing release rate, while diameter and layer height had comparatively little effect. These findings help define key design parameters for the PERaME platform. Subsequent investigations will extend this approach to immediate- and controlled-release formulations, to construct a reference database correlating geometry, material composition, and release kinetics, supporting future development of personalised oral dosage forms.

AUTHOR'S STATEMENT
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