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3D printed tablets with internal scaffold structure using ethyl cellulose to achieve sustained ibuprofen release

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Abstract: The object of this study is to prepare and evaluate tablets with predesigned internal scaffold structure using 3D printing to achieve sustained drug release. Model drug (ibuprofen) and sustained release material (ethyl cellulose), together with other excipients, were firstly mixed and extruded into filaments by hot melt extrusion. Then these obtained filaments were printed into tablets by fused deposition modeling. The tablets printability and drug release behavior were influenced by drug content, release modifiers, printing parameters and modeling. An optimized and completed drug release within 24 hours was achieved by adding certain amount of release modifiers and by adjusting the fill pattern, fill density and shell thickness of models. Drug release profiles and tablet integrity by scanning electron microscope indicated that drug released from these printed tablets through a diffusion-erosion mechanism. All results demonstrated that 3D printing is a highly adjustable and digitally controllable technology that can be applied to produce release-tailored medications.

Keywords: 3D printed tablets; internal scaffold structure; ethyl cellulose; hot melt extrusion; fused deposition modeling; sustained release

1. Introduction

3D printing is an additive manufacturing technology, in which layers of material

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Abbreviations: FDM, fused deposition modeling; PVA, polyvinyl alcohol; EVA, ethylene vinyl acetate; HME, hot melt extrusion; PLA, polylactic acid; EC, ethyl cellulose; HPMC, hydroxypropyl methylcellulose; SA, Sodium alginate; XG, xanthan gum; E_r, radial expansion coefficient; D_f, diameter of filament; D_0, diameter of die; SEM, scanning electron microscope; DSC, differential scanning calorimetry; TG, thermal gravimetric; W_0, initial width; T_0, initial thickness; F_{max}, ultimate load; σ_b, tensile stress at break; Q_{2h}, cumulative drug release at 2 h; Q_{24h}, cumulative drug release at 24 h. R, correlation coefficients