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Abstract

Highly drug particle-loaded polymer composites for the controlled drug release from 3D-printed dosage forms

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By applying the polymer-based filament 3D printing for individualized medicines, dosage forms can be produced on demand with specific shape, dose, drug combination, and release behavior of each drug. The basis to this are pre-manufactured filaments, which are typically produced via hot melt extrusion by incorporating the drug in a melt of a water-soluble or swelling polymer. In such polymer melts, most of the applied drugs are at least partially soluble depending on concentration and temperature. Dosage forms can then be produced with a 3D printer out of a single or several filaments. To gain the maximum flexibility for designing these macroscopic properties, especially for drug combinations, the drug content inside each of the filaments needs to be maximized. However, by maximizing the drug content in the filament, the processing can get challenging due to increased disperse load and thus increased brittleness and melt viscosity as well as possible nozzle blockage during 3D printing. To describe highly loaded polymer drug composites, the partial solubility of the drug particles, the resulting particle size, and shape alteration of the particles along the multi-heating process chain are to be addressed. Due to the need for highly loaded filaments and the challenges that occur in composites with high disperse loads, gaining fundamental knowledge of the particle size and shape development is the focus of this study.

Therefore, several drugs were compounded via hot melt extrusion of different polymeric matrices with varying drug loads. The produced filaments were analyzed regarding their homogeneity, mechanical properties and drug particle size distribution. Finally, applicable filaments were used for the printing of single- and dual-material dosage forms, which were finally investigated. Hence, the microscopic structures [1], their correlation with formulation and process parameters and their effect on further processing and macroscopic application-relevant properties of the final product were elucidated. Furthermore, the release kinetics of combined dosage forms were evaluated and modeled [2].

The results of microscopic and macroscopic investigation provide fundamental insights in the complex interdependencies of highly loaded drug polymer composites and can support future material and dosage form design for an individualized medicine supply.

AUTHOR'S STATEMENT

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REFERENCES

[1] Tidau, M., Finke, J.H., 2024. Dispersion state analysis in hot melt extruded, highly drug-loaded 3D printing filaments applying Raman microscopy. RPS Pharmacy and Pharmacology Reports 3, rqae007.
[2] Tidau, M., Finke, J.H., 2022. Modified release kinetics in dual filament 3D printed individualized oral dosage forms. European journal of pharmaceutical sciences 175, 106221.

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