Effects of Supersaturation on Drug Release Rate for a Polyurethane Film

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Introduction

Current biomedical drug delivery systems struggle to solve issues regarding toxicity, inconsistent delivery rates, and poor target specificity [1]. In particular, a consistent release rate over time is highly desirable to improving treatment outcomes [2]. This research project aims to identify how drug release rate kinetics of a polyethylene glycol and polypropylene glycol based polyurethane are affected by drug supersaturation levels.

Materials

Polyethylene glycol & polypropylene glycol-based polyurethane (Fig 1).

Model drug, Rifampicin loaded at 5 (mg/mL).

Figure 1. Image of synthesized polyurethane film loaded with Rifampicin.

Methods

The polyurethane was synthesized and dissolved in ethanol:water (90:10). The solution was supersaturated with 5 mg/mL Rifampicin and then cast into a film (Fig 1.). Cut out Samples were placed in water and UV-Vis Spectrometry was performed at multiple time points to determine absorbance and concentration.

Figure 2. Image of Sample A

Results & Discussion

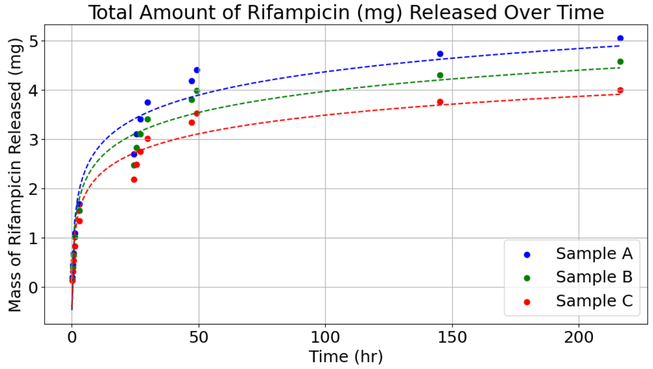

Figure 3. Mass of drug released (mg) with respect to time (hours). Taken aliquots (1 mL) were analyzed with UV-Vis spectroscopy with a fresh medium replacement following each taken sample.

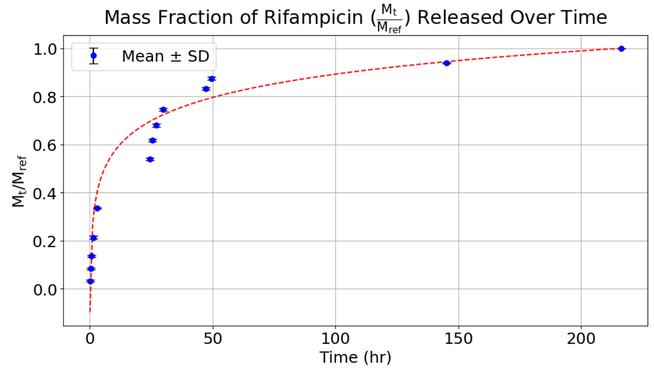

Figure 4. Fractional drug release (M_t/M_{ref}) with respect to time (hours). Each point is graphed as Mean $\pm$ SD (n=3). As a result of low variability, error bars are small.

All samples exhibit an initial burst release followed by a slower approach to equilibrium. Release behavior is consistent with diffusion dominated transport with a dissolution component.

Conclusion & Future Directions

The release profiles reflect supersaturated drug loading conditions and exhibit an initial burst, followed by a slower release phase. This behavior is consistent with a diffusion-controlled process coupled with a first-order dissolution term. However, the effect of supersaturation can't yet be quantitatively determined. Future directions include varying supersaturation ratios, applying a diffusion & first-order dissolution model to extract kinetic parameters, and performing more replicates.

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Works Cited

[1] Tobechukwu Christian Ezike *et al.*, "Advances in drug delivery systems, challenges and future directions," *Heliyon*, vol. 9, no. 6, pp. e17488–e17488, Jun. 2023, doi: https://doi.org/10.1016/j.heliyon.2023.e17488.

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