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DESIGN AND DEVELOPMENT OF A NOVEL DIFFUSION CELL FOR ADVANCED UV IMAGING TO CHARACTERISE PHARMACEUTICAL FORMULATIONS

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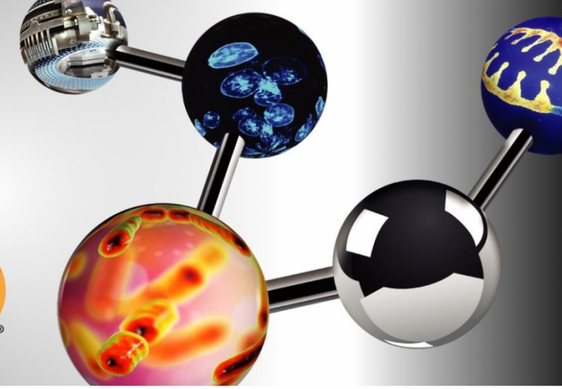


PURPOSE

Permeation tests are conducted to study API release from semisolid formulations to predict in vivo performance [1]. United States Pharmacopeia [2] details the Franz cell diffusion-based evaluation of a topical formulation. In this method, a topical formulation is administered into a donor chamber and permeation or diffusion is evaluated by quantifying the concentration of the drug in the receptor chamber. The traditional permeation quantification method requires small test samples taken from the bulk solution and determined using offline techniques. This can be labour-intensive and prone to human errors.

Therefore, there is a need for real-time monitoring methodologies that can determine and provide insights into the permeation events more precisely. This has led to the development of a novel 3D-printed cell defined in this poster that allows a non-intrusive real time UV imaging across synthetic membranes to characterise the permeation of a topical formulation. This was achieved using a second-generation surface dissolution imaging instrument (SDI2). The authors are currently not aware of any work in developing a Franz set-up that allows UV imaging permeation events in real time.

OBJECTIVE(S)

Aim

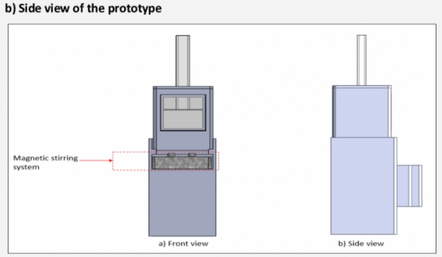
- Design and development of a novel diffusion cell (Franz cell) prototype suitable for UV imaging to characterise permeation of topical dosage forms through skin mimics.

Objectives

- 3D modelling of the Franz cell prototype model using SolidWorks® CAD.
- Manufacturing Franz cell prototype using a 3D printing technique.
- Testing manufactured prototype by using UV imaging for possible improvements.

Design

Figure 1. 3D CAD model of the assembled cell
a) Front view of Franz cell prototype with dosage tube, magnetic stirrer and stand
b) Side view of the prototype



(Patent protected)

METHOD(S)

A 20 x 20 mm (H × L), 0.13 mm thick Silatos™ silicone membrane was placed in a glass beaker. Next, approximately 40 mL of phosphate buffer (pH 7.2) was added to the beaker. The beaker containing the membrane and buffer was then placed in a sonic bath for 10 min to degas and then placed in a water bath at 37 °C to equilibrate for another 20 min. Before the UV imaging assessment, the lower receptor compartment of the 3d-printed cell was filled with approximately 30 mL of degassed phosphate buffer (pH 7.2) using a syringe. Next, the silicone membrane of thickness 0.13 mm was placed on a divider between the donor and receptor compartments providing a diffusion area of 3.14 cm^2. The membrane was sandwiched between the aligner and the Franz cell divider.

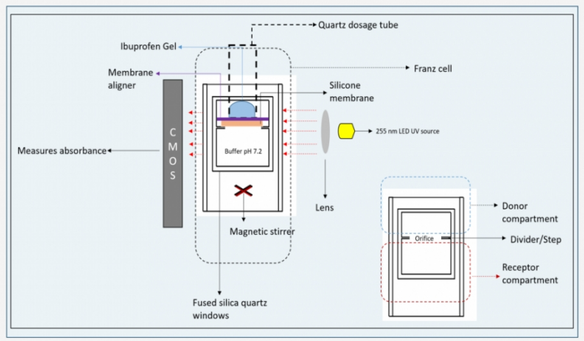


Figure 2. Schematic of the setup to quantify the amount of IBU permeating through a silicon membrane.

A method was constructed using the SDI2 data collection software to record UV data using the 255 nm LED to quantify drug absorbance for 12 h at 37 °C. First the cell was secured in the SDI2 UV imager to blank the system for setting a benchmark value for the UV absorbance. After blanking, the donor compartment of the cell was filled with approximately 1 mL of an ibuprofen gel topical formulation administered using a 5 mL syringe. The whole assembly containing the Ibuprofen gel (Figure 2) was placed in the SDI2 UV imager. The magnetic stirring system was turned on and the speed set to 600 rpm. The experiment was conducted for 12 h in triplicate.

RESULT(S)

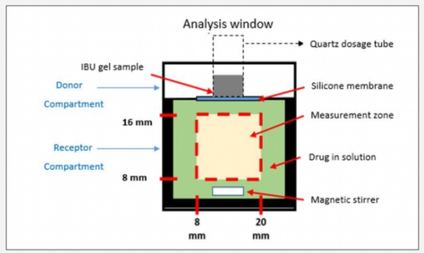


Figure 3. UV imaging measuring zone.

The analysis software supplied with the SDI2 system was used to set up a measuring zone to extract the permeation data (Figure 3). The permeation absorbance data was processed using calibration curves previously determined from the manufactured prototype. The absorbance readings at 30 s intervals were extracted from the software and converted to concentration. Example UV images obtained at selected timepoints from the permeation of Ibuprofen from the topical gel formulation are depicted (Figure 4). The UV images directly show an increase in Ibuprofen concentration crossing the membrane and reaching the receiver chamber over the 12 h period. The average ibuprofen permeation concentration and standard deviation is shown for the entire experiment (Figure 5).

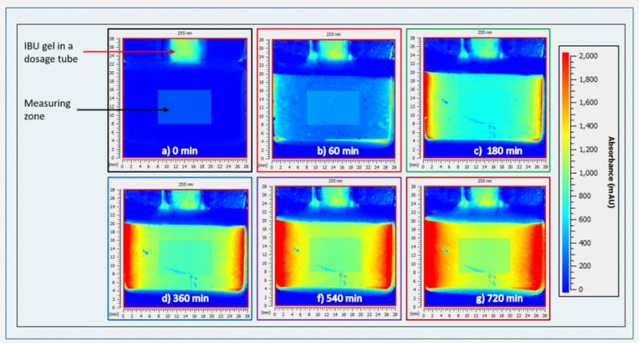


Figure 4. UV images of the Franz prototype ibuprofen permeation at 255 nm for selected time points.
Images are converted to the concentrations shown in figure 5.

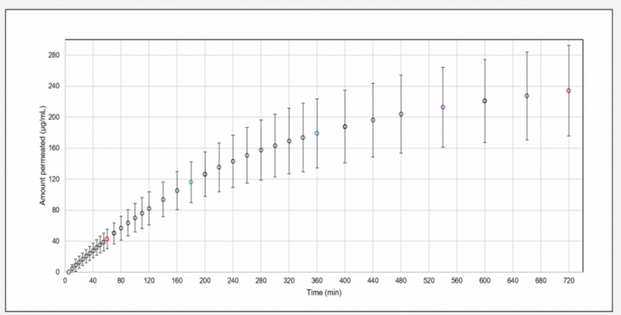


Figure 5. Average ibuprofen amount in µg/mL permeated vs time.
Coloured points correlate with images from Figure 4.

CONCLUSION(S)

A novel permeation cell was successfully developed which facilitated real-time UV characterisation of Ibuprofen permeation from a model topical formulation.

The UV imaging capability of the novel 3D-printed permeation cell allowed the quantification of drug release without the need of manual sampling and provided an autonomous way of gaining additional visual insights from the permeation process.

FUNDING / GRANTS / ENCORE / REFERENCE OR OTHER USE

1. UeCT, Shah VP, Derdzinski K, Ewing G, Flynn G, Maibach H, et al. Topical and transdermal drug products. Dissolution Technologies. 2010; 17(4):12-25.

2. United States Pharmacopeial C, United States Pharmacopeial Convention. Council of E. The United States pharmacopeia [and] The national formulary, 2018: Volumes 1-5. USP: forty-first revision ; NF: thirty-sixth ed. Rockville, Maryland: United States Pharmacopeial Convention; 2017.

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