An assessment of the potential use of a 1cm² hydrogel-forming microneedle patch, in the weekly treatment of osteoporosis

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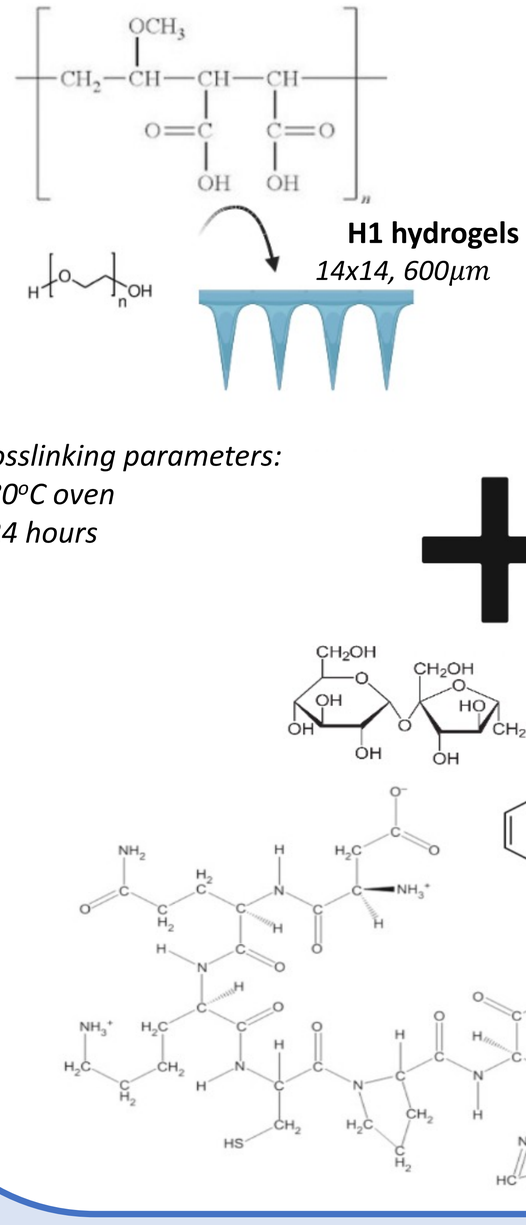
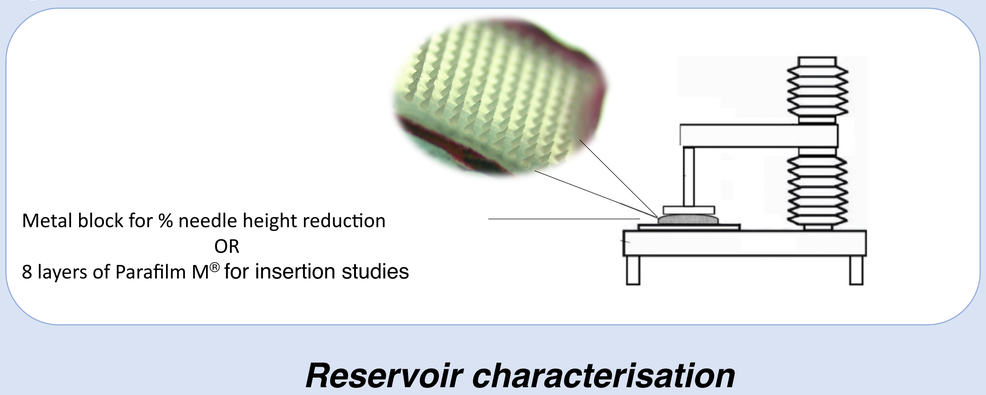
BACKGROUND

Risedronate sodium (RDN) is one of the most common treatment options for osteoporosis, given at a dose of 35 mg weekly. Oral RDN treatment, has been linked to oesophageal reactions, such as esophagitis and ulceration, however, there are currently no marketed transdermal products of the drug. Two types of hydrogel-forming microneedles (MNs) have been developed in the following study, along with lyophilised wafer reservoirs, to deliver RDN *via* the skin, ultimately bypassing the gastrointestinal system, and reducing adverse effects.



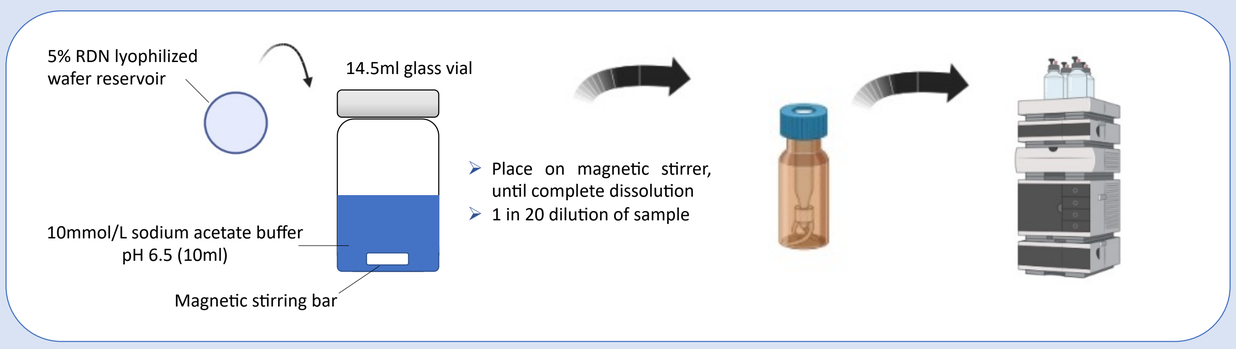
Hydrogel characterisation

The two types of hydrogel-forming microneedles were characterised in terms of % needle height reduction and Parafilm M® insertion profile, using a TA-TX2 Texture Analyser (TA) in compression mode. Following this, a swelling study was carried out, in 10 mmol/L sodium acetate buffer pH 6.5, to determine the % equilibrium water content (EWC) and gel fraction (%) of hydrogels.



Reservoir characterisation

Break force of wafers was determined using TA-TX2 Texture Analyser (TA) in compression mode. Additionally, dissolution times and reservoir RDN content were determined using HPLC, after complete dissolution in 10mmol/L sodium acetate buffer pH 6.5.



Ex vivo permeation study

The permeation of RDN within wafers, *via* the two types of hydrogels, across dermatomed neonatal porcine skin (approximate thickness of 350 µm), was assessed over 24 hours. Franz cells were used in this study.

RESULTS & DISCUSSION

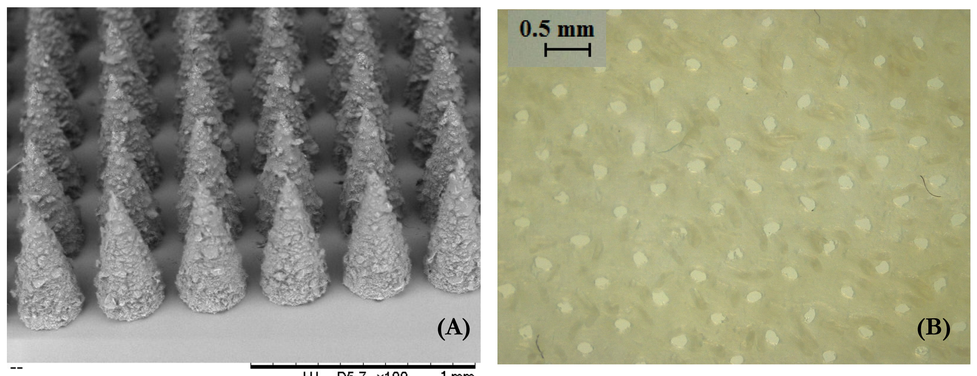


Figure 1. Scanning electron microscope image of hydrogels (A) and insertion into dermatomed piglet skin post *ex vivo* experimentation (B)

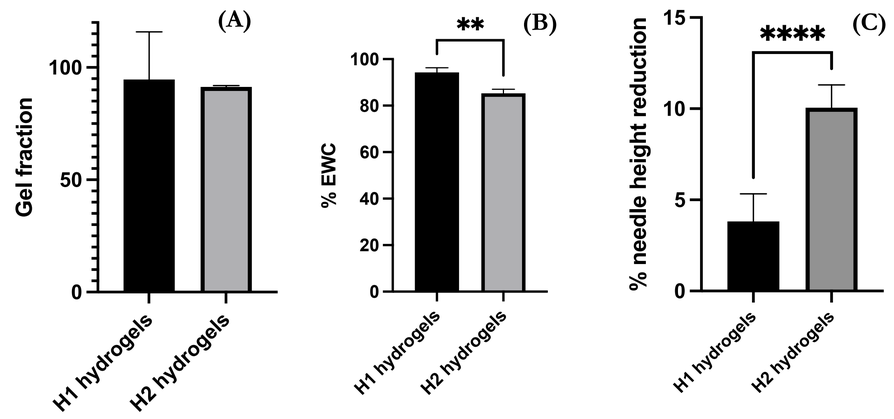


Figure 2. A comparison of H1 and H2 hydrogels in terms of gel fraction (A), % EWC (B) and % needle height reduction (C) (Means + SD, n=5)

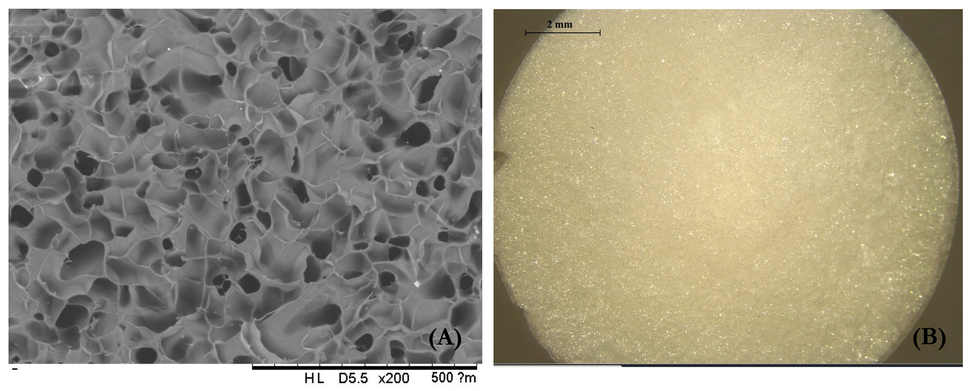


Figure 3. Scanning electron microscope image of 5% RDN lyophilized wafer surface (A) and microscope image of wafer appearance (B)

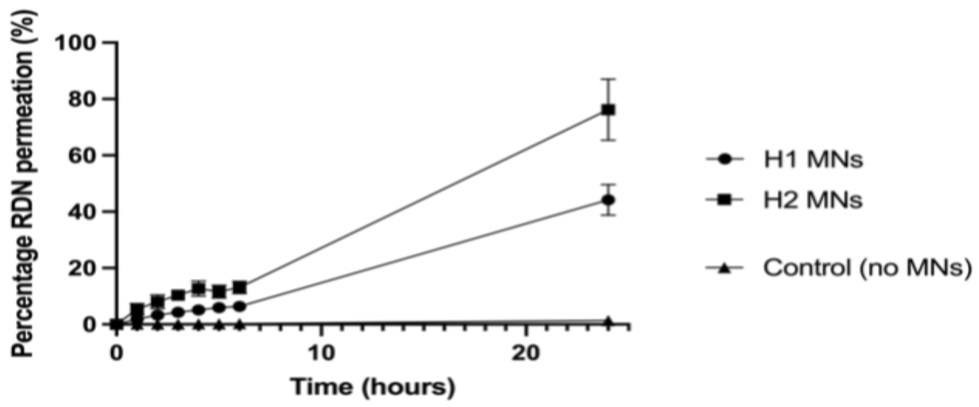


Figure 4. Percentage cumulative RDN permeation in *ex vivo* studies *via* a 1cm² MN patch (Means ± SD, n=3)

CONCLUSION

- Two types of hydrogel-forming MNs were developed, along with a lyophilised wafer reservoir of RDN, and subjected to *ex vivo* studies. The combination of **H2 MNs**, with a lyophilised wafer containing RDN, was most successful at delivering the drug over 24 hours.
- A total of **76.2 ± 11%** of RDN permeated across porcine skin, delivering approximately **17 mg of the drug**, *via* a 1cm² patch, made of **H2 hydrogels**. A very promising figure, considering the dose of the drug (35 mg weekly).

The delivery system will be taken forward to *in vivo* studies, to assess its therapeutic efficacy. Osteoporotic bone will be visualised before and after treatment, using X-ray and scanning electron microscopy. Additionally, bone mineral content will also be examined, to assess the effect of the drug delivered *via* a novel transdermal product.

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