Introduction

Advanced delivery systems have proven their efficacy in improving skin delivery, but often lack customisable, cost-effective methods. Through the Formulation for Efficacy (FFE) concept it is possible to optimise skin delivery using affordable raw materials and equipment [1]. FFE has been used to improve the delivery of hydrophilic compounds, but there is limited information on hydrophilic compounds.

N-acetyl-D-glucosamine (GlcNAc) is a monomer of hyaluronic, an important skin component both structurally and physiologically; it is hydrophilic (log \( P = -2.1 \)) and has shown to be a versatile and efficacious cosmetic ingredient [2,3].

Methods

Solubility studies were performed with GlcNAc in water, glycerol and propylene glycol (PPG).

Carbomer (0.5%) hydrogels, neutralised to pH 6.0 with NaOH, were formulated with the following ratios of solvents:

- water (F1);
- water : glycerol at 1:2, 1:1 and 2:1 (F2, F3 and F4, respectively);
- water : PPG at 1:2, 1:1 and 2:1 (F5, F6 and F7, respectively);
- and water : glycerol : PPG at 1:1:1 (F8).

In vitro release studies were performed with vertical Franz diffusion cells (VDC Test System Model HDT 1000, Copley Scientific™, UK) and HT Tuffryn® membranes (Pall Corporation®, USA) (pore size = 0.2 µm); the receptor phase was a phosphate-buffered solution (pH 7.4) kept at 32°C and stirred at 500 rpm. Samples were collected after 0.5, 1, 2, 3 and 4 h. Under the same conditions, in vitro permeation studies were performed with Strat-M® membranes (EMD Millipore, Germany). GlcNAc was quantified by UV spectroscopy at 202 nm with a NanoDrop™ 2000 (Thermo Fisher Scientific, UK).

Results

The solubility of GlcNAc was: 206.333 g.L\(^{-1}\) in water, 40.375 g.L\(^{-1}\) in glycerol and 7.390 g.L\(^{-1}\) in PPG.

The hydrogels that presented the best in vitro release profiles were: F1, F2, F3, F7 and F8 (results shown in Figure 1). In the in vitro permeation studies, the best profiles were obtained with the hydrogels F6 and F8 (results shown in Figure 2). GlcNAc was more soluble in glycerol than PPG, which corresponded to better release profiles obtained for higher concentration of glycerol and lower concentration of PPG. This suggests that if the solubility of the active is reduced below an optimal level, its release may be hindered.

Conclusions

- The solubility of the active in the formulation and in the membrane appears to be critical in topical delivery.
- The ability of PPG to aid in the permeation of GlcNAc similarly to glycerol may be due to its log \( P \) being closer to that of the Strat-M® membrane [4].
- When both solvents were used, both the higher solubility of GlcNAc due to the presence of glycerol and the presence of PPG (lower log \( P \)) seemed to increase the driving force through the membrane [1].