



# BIOPHYSICAL TECHNIQUES TO CHARACTERISE SKIN PERMEABILITY



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## Background

Biophysical techniques have become more sophisticated and sensitive and have been applied to interrogate the barrier properties of the skin. Transepidermal water loss (TEWL) is the steady-state water vapour flux crossing the skin. Attenuated Total Reflectance – Fourier Transform Infrared (ATR-FTIR) spectroscopy is used to study various biophysical properties of the *stratum corneum* (SC), e.g. the phase behaviour of lipid membranes. Tape-stripping of the SC collects **corneocytes** and hence can be used to measure their surface area (A). The permeation of methyl nicotinate (MN) is used as a chemical measurement of skin barrier function as it induces an erythema.

## Aim

The aim of this work is to investigate how the biophysical techniques may be used together with corneocyte size and erythema onset time to characterize skin permeability.

## Methods

Measurements were performed at four different anatomic sites of the volar forearm in 50 volunteers, males and females, Caucasians and Asians, non-smokers, with no skin disorders.

- **ATR-FTIR** spectra were recorded using a Tensor 27 (Bruker) spectrometer equipped with a Fiber Mate 2TM (Harrick). Spectra were registered and evaluated with Opus 5.5 software with a resolution of 4cm<sup>-1</sup>, 186 scans.
- **TEWL** was measured with an Aqua Flux (Biox) instrument.
- **Corneocytes** were collected by tape stripping, flushed from the tape with HPLC-grade hexane, sonicated for 15 minutes and then observed at the microscope. Surface area (µm<sup>2</sup>) was measured using Image J software.
- **MN** solution 0.075% in water was applied for 20 seconds to 1cm<sup>2</sup> of skin using a pre-soaked filter paper. Erythema onset time was determined when the

## Results

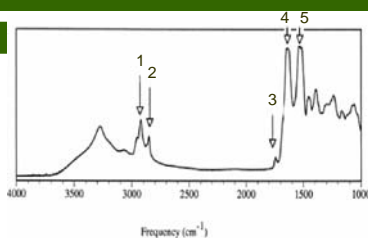


Figure 1: Typical ATR-FTIR spectrum obtained → 1) CH asymmetric (lipids); 2) CH symmetric (lipids); 3) C=O (fatty acids); 4) Amide I (hydration); 5) Amide II (proteins).

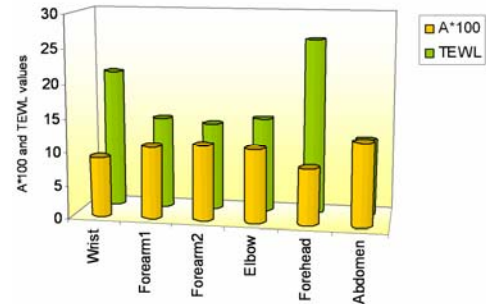


Figure 2: Plot of corneocyte size and TEWL in each anatomic site. Statistics: TEWL forehead > wrist > forearm1 = forearm2 = elbow = abdomen p<0.05 Area forehead < wrist < forearm1 = forearm2 = elbow < abdomen

Publications by Rougier and Ya-Xian indicate that the smaller the corneocytes, the fewer the number of layers. A suggested equation is  $n = (A^{1/2} - 20)/0.75$  which gives n as: wrist 13, forearm 17, elbow 17, forehead 12 and abdomen 20. [1,2]

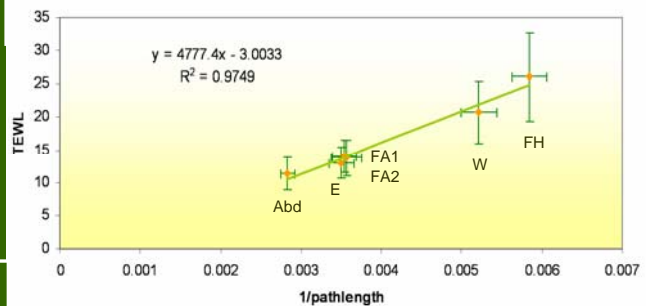


Figure 3: Plot of TEWL vs 1/pathlength. Pathlength =  $n + [A^{1/2}(n-1)/2]$  (Abd, abdomen; E, elbow; FA, forearm; W, wrist; FH, forehead).

Considering all ATR-FTIR spectra obtained, no differences between anatomic sites were noticed for the total amount of lipids, proportion of fatty acids and hydration. According to figure 2, TEWL is inversely related to corneocyte size i.e. the larger the corneocytes the lower the TEWL. Additionally, a linear correlation between TEWL and 1/pathlength is shown in figure 3. Erythema onset time showed no correlation with the other techniques. None of the techniques revealed differences within genders or races.

## Conclusions and Future Work

In this study, some trends were noticed and correlations between TEWL and corneocyte size were observed. In future work, we will investigate how the barrier function can be improved with topical formulations.

## References

1. Rougier, A., et al.; "Relationship between skin permeability and corneocyte size according to anatomic site, age and sex in man", J. Soc. Cosmet. Chem., 39 (1988) 15-26
2. Ya-Xian, et al.; "Number of cell layers of the stratum corneum in normal skin – relationship to the anatomical location on the body, age, sex and physical parameters", Arch. Dermatol. Res., 291 (1999) 555-559