Penetration of Glycerin into the First Layers of Stratum Corneum measured by in vivo Raman Spectroscopy

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Aim
The purpose of this pilot study was to evaluate the penetration of glycerin into the stratum corneum by using the non-invasive in vivo confocal Raman spectroscopy in order to gain deeper understanding on the positive effects of glycerin containing cosmetics on human skin.

Methods
For the investigations a confocal Raman spectrometer (River Diagnostics Model 3510 Skin Composition Analyzer; RiverD International B.V., Rotterdam, The Netherlands) was used to measure the fingerprint region of the Raman spectrum (400-1,800 cm⁻¹) at different depths. Glycerin penetration assessments were performed on three test areas on the volar forearms of two healthy female adult subjects (41 and 48 years of age) with dry skin according to self-assessment. Subjects stayed in an acclimatized room (21 ± 1°C and 50 ± 5 % relative humidity) for at least 30 minutes before and during the measurements. After baseline measurements 2 mg/cm² of the test product, a basic cosmetic water-in-oil formulation with 10 % glycerin, was applied. One hour, two hours and 24 hours after the application, the amount of glycerin and keratin was measured by Raman spectroscopy in up to 9 depths below the skin. A scheme of the Raman spectrometry set-up is shown in Figure 1. Before recording in vivo penetration profiles a Raman spectrum of the raw material (glycerinium anhydricum) was recorded in vitro. The recorded glycerin spectrum was added to the normalized skin spectrum of the River D software [4] in order to calculate the in vivo glycerin amounts. Keratin normalized glycerin concentration profiles were summarized to mean concentrations over the repeated measurements on treated test area and depth.

Conclusions
Confocal Raman spectroscopy is a non-invasive technique that has a number of applications to investigate non-invasively the molecular composition of human skin in a qualitative and semi-quantitative manner. Among other applications, the Raman method can be used to measure the penetration of topically applied active like retinol [1] or urea [2]. Our results clearly show that glycerin penetrates into the outermost third of the stratum corneum and that the Raman technique is capable to easily follow the penetration of Glycerin into the skin. The results also show that no enrichment of the glycerin in the horny layer occurs. Glycerin is continuously depleting from stratum corneum by penetration. It seems that a steady flow of glycerin penetration is quickly reached (already one hour after application), as no differences between the profiles of the one and two hour assessments were found. To keep relevant amounts in the stratum corneum regular re-application of about one treatment per day is required. The positive, clinical effects of glycerin on dry skin, which is observed for time ranges up to 24 hours, are in good accordance with the observed glycerin in the stratum corneum. Differences between subjects in Glycerin amounts on the skin surface and in the upper third of the stratum corneum, might be explained by differences in sweating or wiping off the product. This pilot study showed the benefit of the Raman technique as a fast, reliable and direct non-invasive in vivo method to evaluate the degree of penetration of cosmetic actives as glycerin into the skin.

Literature