Quantitative methods for spatially resolved measurement of skin penetration of cosmetics and pharma ingredients
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Abstract

Both in the field of pharmaceuticals, as well as in the cosmetics industry, understanding the penetration of the active ingredients and their distribution in the skin after penetration holds great importance. The complexity of a biological system like the human skin, though, makes the permeation procedure unpredictable. Traditionally, numerous techniques were coupled with high performance liquid chromatography to quantify the transdermal delivery of the pharma- and cosmetics actives. Unable to localise the active compounds, these techniques focus on analytes™ gross transport. Many of these studies also used animals, which mainly for ethical reasons highlights the need for new techniques for studying the penetration of the important compounds in the skin.

Localised information is needed to better understand the skin diffusivity but also the specific penetration pathways that the compounds follow. For that reason, a review of the available techniques found in literature was given in this study. Techniques like Franz diffusion cells and tape stripping, which provide gross transport information were first discussed. The main focus of this review, though, were the more recently developed techniques providing also location-specific information on the degree of penetration of the compounds. Confocal laser scanning microscopy (CLSM), confocal Raman microscopy (CRM), time-of-flight secondary ion mass spectrometry (ToF-SIMS) and matrix assisted laser desorption/ionization mass spectrometry imaging (MALDI-MSI) were the methods discussed taking also into account their advantages and limitations. Additionally, a comparison of these techniques regarding their quantitation capabilities and the provided spatial resolution, sensitivity, etc. was carried out. For example, the achieved spatial resolution using these techniques is ranging from submicrometer values for CLSM and ToF-SIMS to 10-50 μm values for MALDI-MSI. On the other hand, MALDI-MSI is sensitive enough (μM region) to identify multiple analytes at the same time without the use of labels, like CLSM and without requiring a distinctive Raman spectrum, like CRM. In conclusion, each and every technique is unique and in order to select a spatially (or not) resolved technique to evaluate the penetration of cosmetics or pharmaceuticals, the needs of the specific application have to be considered.