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Differential scanning calorimetry on human nail clippings, keratin films and bovine hoof plates – effect of formulation ingredients

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Introduction:
Differential scanning calorimetry (DSC) measurements are employed to analyse the interaction between formulations and human stratum corneum (SC). If the SC is heated up to 120 °C, four endothermic transition shifts are detected (T1 – T4) with T2 und T3 appearing reliable in each thermogram (Barry, 1987). In this contribution, we analogously tried to investigate the influence of excipients and formulations on nail clippings and nail plate models. As nail plate models, keratin films (KF) manufactured according to Lusiana et al. (2011) and bovine hoof plates were utilised. The formulations included in this assay were composed of poloxamer 407 (P407), propylene glycol (PG), isopropyl alcohol (IPA), medium chain triglycerides (MCT), double distilled water and the antifungal active ingredient ciclopirox olamine.

Methods:
The P407-based formulations were manufactured according to Täuber and Müller-Goymann (2015). DSC measurements were carried out to evaluate the interaction between excipients/formulations and nail clippings as well as artificial nail plate models. Prior to the experiments, nails, KF and bovine hoof plates were hydrated in a desiccator filled with saturated sodium chloride solution for at least 48 h at room temperature. Following, insertion either in the excipient or in the P407-based formulation (n = 3 – 5) for 0.5 – 3 h at 32 °C was carried out. Subsequent DSC measurements were executed from 30 – 250 °C with a heating rate of 20 K/min by using a DSC 1 MultiSTAR HSS7 System (Mettler Toledo GmbH, Gießen, Germany).

Results:
When heating up nails and nail plate models to 250 °C, three endothermic transition shifts (T1 – T3) were detected. However, only T2 appeared reliable in each thermogram and was hence used for evaluation. T2 of the nail plate models was detected at approximately 140 °C, whereas T2 of the nail clippings was at 167 °C. Incubating the nail clippings for 0.5 h in the excipients led to a slight increase of T2 with exception of water. Regarding the nail plate models, only MCT evoked a considerable transition shift. Prolonging incubation time up to 3 h evoked an increase of T2 for all membranes when incubating them in PG and IPA,

respectively, despite high standard deviation (SD) up to 29 °C in the case of IPA. Incubation of nails and nail plate models in the P407-based formulations for 0.5 h did not evoke significant transition shifts of T2.

Conclusion:
Influence of excipients on nails and nail plate models could be measured with DSC. Both nail plate models indicated similar transition shifts, but differed from human nail clippings.

References:
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