Oil penetration into the human skin

For a long time, oils have been the basis of many skin care products and ointments in the cosmetic industry and medicine. Oils are supposed to be non-penetrating substances, therefore they are neutral for the human skin and do not cause any harm. Nevertheless, the oil penetration depth into the human skin is controversially discussed in the scientific literature. Some studies show that cosmetic oils are able to permeate the skin barrier and reach the viable cells of epidermis.

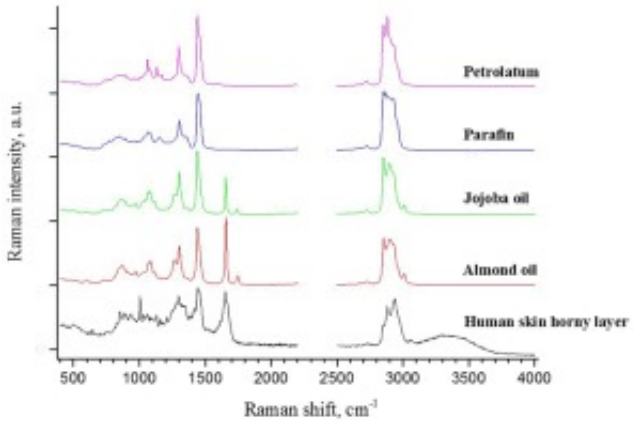

Fig. 1. Raman spectra of selected oils in comparison to intact human skin (horny layer at a depth of 4 um)

In the reported study, the penetration ability of exemplary pharmaceutical refined high-quality oils (almond oil, jojoba oil, paraffin oil and petrolatum) was investigated on 6 healthy volunteers aged between 23 and 62 years. The oils were evenly applied at an amount of 2 mg/cm^2 upon marked areas of 2x2 cm^2 of the inner forearm. After one hour, every oil-treated area was measured at least ten times down to a depth of 30 µm inside the skin at increments of 2 µm. For this purpose, a sophisticated optical measuring system, confocal Raman microscope (River Diagnostics, Model 3510, Rotterdam, Netherlands), was used. The resulting Raman spectra (Fig. 1) were subsequently analysed using four independent methods in order to determine the oil penetration profile into the skin. Oils covering the skin surface interfere the water evaporation from the skin. As a result, water is absorbed by the horny layer of the skin giving rise to its swelling. The values of the oil-induced swelling effect and the values of oil penetration depths obtained using the four different methods are summarized in Table 1.

It was found that the penetration depths of the investigated oils determined by methods 1, 2 and 4 are comparable to each other. They range between 5 and 8 ?m. The penetration depths obtained using method 3 are significantly higher. A detailed analysis of the technical aspects of the method 3 shows that it provides incorrect, namely higher, values of the penetration depths as the

superposition of the lipids and keratin (important components of the horny layer) measured in a specific wavelength range is not considered. The separation procedure of lipids and keratin from each other developed in the method 4 shows the correct results, which is comparable with results obtained using other methods and other optical techniques.

	Method 1 (µm)	Method 2 (µm)	Method 3 (µm)	Method 4 (µm)	Swelling of SC (%)
Almond oil	5.1± 2.4	6.7 ± 0.75	8.8 ± 0.75	6.8 ± 0.4	9.2 ± 12.0
Jojoba oil	4.9 ± 1.4	7.3 ± 1.6	10.7 ± 2.7	8.0 ± 3.1	3.7 ± 6.1
Paraffin oil	n/a	6.8 ± 0.9	15.3 ± 5.3	6.5 ± 1.6	10.6 ± 7.3
Petrolatum	n/a	7.0 ± 0.8	20.7 ± 4.9	6.3 ± 1.2	31.5 ± 5.2

Tab. 1. The oil penetration depths into the volunteers' skin determined by the four different methods and the value of post-treated swelling of the horny layer (mean ± standard deviation). n/a – not applicable.

Thus, taking into consideration the strong limitations of method 3, it is concluded that the investigated oils do not reach the viable cells of epidermis, saturating only the uppermost horny layers of the skin. When confocal Raman microscopy is applied for investigating the penetration properties of oils or oil-containing formulations, the methods 2 and 4 are highly recommended as they have proven to be the most exact and suitable ones.

Publication

Confocal Raman microscopy for investigating the penetration of various oils into the human skin in vivo.
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