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The Impact of Hair Cleansing Products on Human Scalp, Evaluated by In Vivo Confocal Raman Spectroscopy

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Introduction

A number of non-invasive methods are available to measure an impaired status of the scalp as dryness or barrier damage. However, these methods are sensitive only if damage has already occurred. An early indicator for the scalp tolerability of hair washing products is the amount of extracted scalp components like natural moisturization factors (NMF). In vivo confocal Raman spectroscopy is a suitable method to measure it. A laser beam of 1 µm is directed under microscopic control to a series of scalp areas, not covered by hairs, and Raman spectra at different depths of the stratum corneum are directly assessed.

Materials & Methods

Participants

This nonmedical study on healthy human subjects was executed according to the principle requirements of the declaration of Helsinki and according to the main principles of Good Clinical Practice (GCP). Volunteers were informed orally and written on the study details including potential risks and inconveniences. They provided their written consent before they were included in the study. Two panels of 6 female subjects with healthy, dandruff-free scalp participated in the study. All participants have been surveyed prior to the start of the study in order to ensure that all inclusion and exclusion criteria were fulfilled.

Inclusion criteria

Healthy female subjects between the ages of 18 and 45 years old with a body mass index of 30 or less were recruited. All participants had average hair length and were non-smokers. In addition, all participants were asked to wash their hair with their own hair shampoo the evening before the study day to avoid greasy hair.

Exclusion criteria

Subjects in a state of pregnancy or lactation were not included. Use of topical medication on the scalp, alopecia or freshly dyed hair further was an exclusion criterion. Subjects with irritated scalp skin, tattoos, big moles or who went through systemic therapy with immunosuppressive drugs (e.g. corticosteroids) and/or antihistamines (e.g., anti-allergics) during the 7 days prior to the study start were excluded.

Raman spectroscopy

The instrument used in this study was a “gene2-SCA Ultimate”. This instrument is a confocal RAMAN system of high sensitivity designed for in vivo skin analysis. In this study, a pinhole of 50 µm was used to record the Raman signal in a depth of up to 28 µm in the scalp skin. The gen2-SCA Ultimate has two built-in lasers (wave class 3B lasers, 671 nm and 785 nm). In this study we used the laser with a wavelength of 785 nm which is near-infrared (NIR). It records the “Raman fingerprint region” with wavenumbers from 400 to 1800 cm–1. All components measured display a distinct and intense Raman spectrum in this range.

Test products

Three wash active substances were used in this study: SDS, sodium laureth sulfate with 2 Mol ethylen oxide (SLES) and decyl glucoside (DC). These actives were dissolved in water at a concentration of 13.4% each and applied to the subjects scalps.

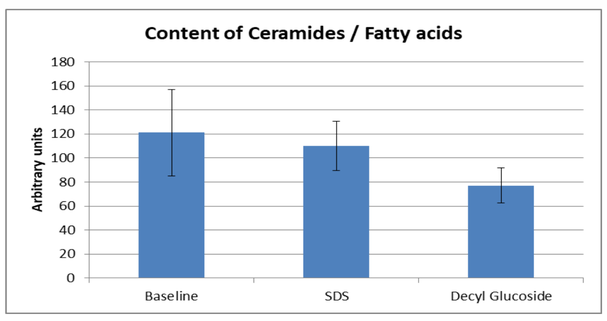
Conclusions

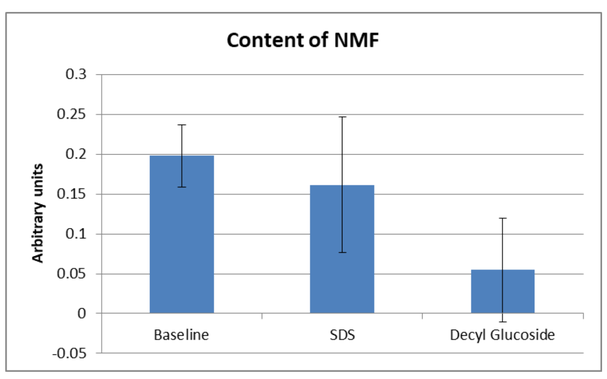
Actually we perform additional measurements that might help to explain the surprising results. It is well known that the clinical skin drying and damaging effect of SDS is clearly higher than that of SLES and DG. However, it is known, that only repeated washing or a patch application with SDS is leading to clear skin damage [26]. The wash out effect of water soluble skin molecules from a practical shampooing procedure on scalp might not go in line with the dermal irritation potential of detergents as assessed after patch testing on arm or back. SDS penetrates in large amounts into SC and deeper skin layers most likely via an intercellular lipid permeation pathway (27). Impairment of intercellular lipids and denaturation of enzymes that are steering the desquamation process, as well as direct cell toxicity in the living epidermis might be the main course of the irritant potential of SDS, but not the amount of water soluble molecules extracted from SC.

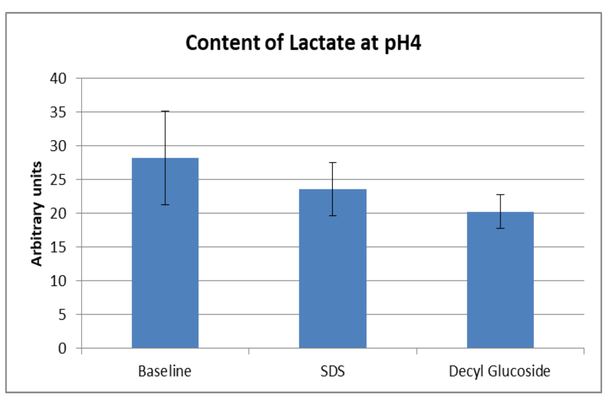
Results & Discussion

In the fingerprint spectra relative amounts of Ceramides/fatty acids, NMF, Lactate at pH4 and Urea were detected.

All three surfactant products led to a washout of all detected skin molecules. It was surprising, that both SLES (not shown) and even DG led to a higher wash out rate than SDS (Figure 1).







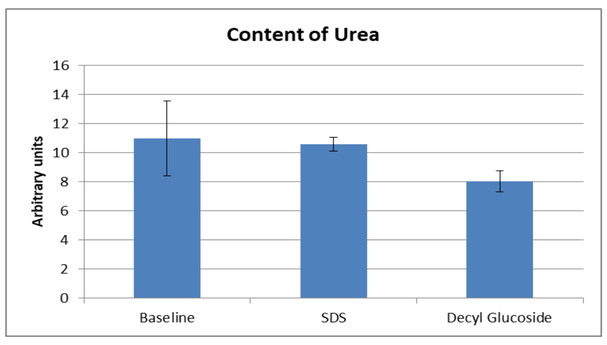


Figure 1 Content of water soluble skin molecules, ceramides and fatty acids together, NMF, lactate at pH 4 and urea directly measured on the scalp before (baseline) and after a practical shampooing procedure. Surprisingly the mild surfactant decyl glucoside removed more water soluble skin molecules than the harsh SDS.

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