Surfactant Association with Hydrophobically-Modified Polymers Leads to Reduced Barrier Perturbation

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INTRODUCTION

While maintaining a strong SC barrier is important for patients with various conditions, even mild cleansers can disrupt the SC barrier. Low molecular weight hydrophobically-modified polymers (HMPs) are particularly efficient at associating surfactant such as sodium lauryl sulfate (SLS) due to the strong interactions with the hydrophobic tail of the surfactant with the hydrophobic domains on the HMP. We have found that surfactant associated with the HMP lowers the effective concentration of free surfactant micelles in solution and reduces the amount of surfactant that penetrates into the skin, thereby reducing the disruption of skin lipids. However, these formulations can still provide the desirable foaming aesthetics and cleansing efficacy desired by patients (data presented elsewhere).[1] Here we show that these large polymer-surfactant complexes are less aggressive to the lipid barrier in the stratum corneum than traditional cleansing systems.

In this study, porcine skin samples were exposed to either a facial cleanser formulation incorporating a HMP, phosphate buffer solution (control) or commercially available, popular dermatologist-recommended benchmark facial cleanser. After this treatment, a lipophilic fluorescent dye, which can penetrate deeply into damaged barrier, was applied to the skin.

Two-photon fluorescence microscopy was used to visualize the morphology of the barrier approximately 60 microns deep into the skin samples. We observed low-level dye penetration into the control sample treated with phosphate buffer for short periods of time. The skin treated with the facial cleanser, featuring the HMP, showed significantly lower levels of dye penetration compared to that observed in the sample treated with the popular benchmark gentle facial cleanser. These results show that this cleanser with the hydrophobically-modified polymer helps to preserve barrier integrity.

MATERIALS & METHODS

Materials

- Full-thickness Yucatan miniature hairless pigskin was obtained from Sinclair Bio-Resources of Auxvasse, Missouri and cut into 2" x 2" specimens.
- Cleansing formulations:
  - a. facial cleanser formulation incorporating a hydrophobically-modified polymer (HMP) (foaming and non-foaming variants)
  - b. commercially available benchmark facial cleanser noted for gentleness (foaming and non-foaming variants)
  - c. phosphate buffer solution (control)
  - d. 1% sodium lauryl sulfate solution (negative control)

Methods

- Full-thickness pigskin was mounted in Franz diffusion cell with phosphate buffer as the receiving solution. The cleansing formulations were diluted with water to 10% and placed in passive contact with the upper surface of the skin for 24 hours.
- The cleanser-exposed skin was rinsed and treated with the lipophilic fluorescent probe dye, Nile Red (NR) and two-photon fluorescence microscopy was used to study the morphology of the skin barrier. All TPM images shown here were obtained 24 microns deep into the skin.

RESULTS

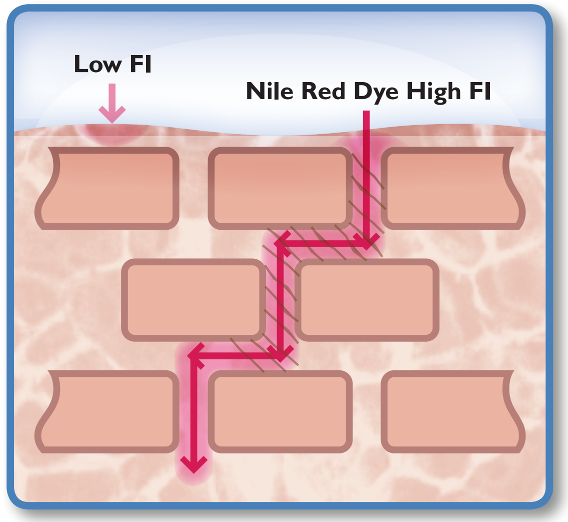

Figure 1. This is a schematic of NR dye diffusion into skin. Skin cells and intact barrier resist diffusion of the dye. Therefore, low fluorescence intensities (FI) will be observed in area where the barrier is more intact. Damaged barrier (slightly cross hatched) provides less resistance to diffusion, allowing more NR to easily penetrate deeper into the skin. Therefore, there will be higher FI in areas where the barrier is damaged.

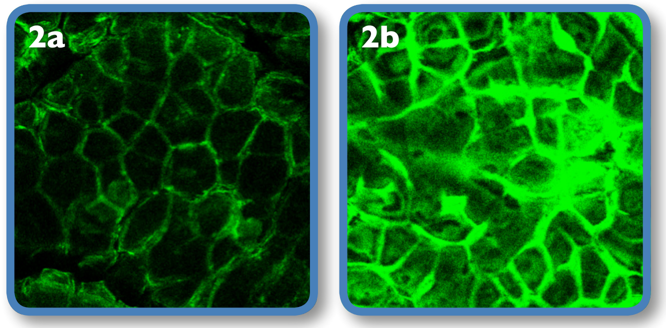

Figure 2a shows the images of cells for the control skin. There is limited NR penetration into this intact barrier.

Figure 2b shows the TPM image for SLS treated skin. Higher intensity of NR shows that there is large penetration of NR indicating the great extent of barrier damage.

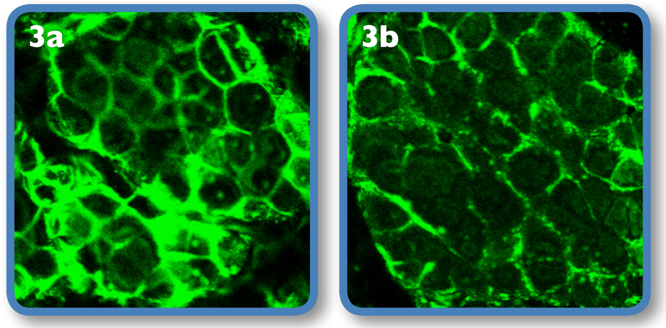

Figure 3a shows skin treated with the dermatologist recommended benchmark foaming cleanser. Higher intensity of NR compared to the control indicates penetration of fluorescent dye due to barrier damage.

Figure 3b shows skin treated with the foaming HMP facial cleanser. NR intensities are lower than that of the benchmark foaming cleanser suggesting lower levels of barrier damage.

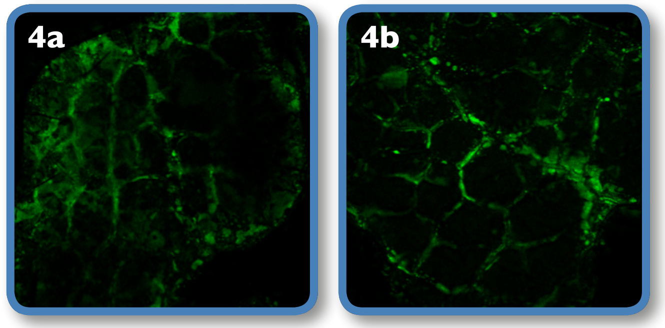

Figure 4a shows skin treated with the benchmark cleanser. The FI is low indicating low levels of barrier perturbation.

Figure 4b shows skin treated with the HMP facial cleanser. NR intensities are comparable to that of the benchmark mild foaming cleanser (fig. 4a) indicating comparable minimal levels of barrier damage.

CONCLUSIONS

- Incorporating hydrophobically-modified polymer into cleansing formulations allow cleaning efficacy and foaming without perturbing the skin barrier.
- The foaming HMP facial cleanser incorporating a hydrophobically-modified polymer was gentler to the skin barrier in this model than the dermatologist recommended benchmark foaming cleanser.
- The non-foaming HMP facial cleanser was as barrier-preserving as the benchmark cleanser.

Reference

1. Zoe Draelos, Sidney B. Hornby, Russell M. Walters, Yohini Appa. *Hydrophobically-modified polymer gentle facial cleansers provide gentle cleansing in sensitive skin subjects*, Poster Presentation, 69th Annual meeting of the Academy of Dermatology, February, 2011.