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A Comparative Analysis of Eight Facial Cleansers Using Corneosurfametry Reveals Differentiated Irritation Potential

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ABSTRACT

Background: Facial cleansers can disrupt the stratum corneum and cause irritation. Selecting a cleanser that is both effective and gentle is foundational to a tailored skincare routine, particularly for individuals with sensitive skin. This project assessed the relative mildness of Cetaphil® Gentle Skin Cleanser (GSC; Galderma Laboratories, LP, Fort Worth, TX) vs 7 other commercially available gentle cleansers using corneosurfametry.

Methods: Surface skin cells were collected from the volar forearms of 18 volunteer participants using D-Squame® standard sampling discs. Discs were then incubated for 10 minutes in a 10% aqueous solution of one of the 8 cleansers, 5% sodium lauryl sulfate (positive control), or water (negative control). Samples were stained with toluidine blue–basic fuchsin and measured by chromameter. Colorimetric index of mildness (CIM) least-squares means were compared pairwise versus GSC, and photographs provided qualitative corroboration. A higher CIM indicated a milder cleanser, while a lower CIM indicated a harsher cleanser.

Results: The mean CIM for GSC was 63.87; pairwise comparisons indicated statistically significant differences between GSC and the mean CIM of the 7 comparators, which ranged from 46.95 to 53.32. Photographic tape appearance was concordant with CIM rankings.

Conclusion: GSC was significantly milder than the comparator cleansers as assessed by CIM and photographic analysis of the tape strips. These data suggest that there are differences in irritation potential among commercially available facial cleansers, which may help ensure patients and providers select a sufficiently mild cleanser for those with sensitive skin.

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INTRODUCTION

The stratum corneum serves as the primary physical barrier of the skin, protecting against environmental insults, microbial invasion, and transepidermal water loss (TEWL).[1] This outermost epidermal layer consists of corneocytes embedded within a lipid-rich intercellular matrix ("brick and mortar" model), and its integrity is essential for skin homeostasis.[2]

Cleansing products are among the most frequently used topical formulations worldwide, and their interaction with the skin is determined largely by the type and concentration of surfactants they contain.[3-5] Although surfactants enable the removal of dirt and sebum, conventional anionic surfactants, most notably sodium lauryl sulfate (SLS), can solubilize intercellular lipids, denature stratum corneum proteins, and induce inflammatory responses.[6,7] Barrier disruption from certain surfactant-based cleansers can contribute to adverse cutaneous responses, ranging from subclinical irritation to clinically evident contact dermatitis.[6] Additionally, the concentration of surfactants, pH, and other components of the final formula can all contribute to the overall mildness of a cleanser.

Sensitive skin is common, affecting up to 70% of people globally, and it can be associated with meaningful quality-of-life impacts for affected individuals.[8,9] Sensitive skin is often characterized by heightened reactivity to topical agents and environmental stimuli, producing symptoms such as stinging, burning, tightness, and erythema in response to products typically tolerated by the general population.[10-12] Proposed mechanisms of this heightened reactivity include impaired barrier function, increased TEWL, and heightened neurosensory responsiveness, which together may increase susceptibility to irritation from surfactant-based cleansing formulations.[10-12]

Consequently, selecting a cleanser that effectively removes impurities while preserving barrier integrity is foundational to managing sensitive skin and developing a tailored skincare regimen.[13] Topical cosmetic formulations can influence stratum corneum hydration and epidermal barrier function; barrier-supportive product selection, therefore, remains an important consideration in individualized at-home skincare routines.[14,15]

Because subjective perceptions of cleanser "harshness" are multifactorial, objective methods that quantify surfactant–stratum corneum interactions can support both product development and evidence-based selection.[16] Corneosurfametry is a method where collected stratum corneum samples are exposed to cleansers, stained with toluidine blue and basic fuchsin, and assessed by reflectance colorimetry.[17] The resulting colorimetric index of mildness (CIM) provides a quantitative measure of corneocyte damage, with higher CIM values indicating less damage and a milder formulation.[16]

Cetaphil® Gentle Skin Cleanser (GSC; Galderma Laboratories, LP, Dallas, TX) is a widely used cleanser formulated for individuals with sensitive and dry skin.[18] Other commercially available cleansers purport to be formulated for sensitive skin, but there is a paucity of data assessing the relative gentleness of these cleansers. Given that sensitive skin is characterized by stratum corneum disruption and dehydration, cleanser mildness is particularly relevant in this population.[19] Data comparing the mildness of cleansers may help consumers, patients, and clinicians make evidence-based product selections. The objective of this project was to assess the relative mildness of GSC compared with gentle comparator cleansers using a corneosurfametry-based methodology.

MATERIALS AND METHODS

Study Participants

Corneocyte samples were collected from the volar forearms of 18 healthy adult participants using D-Squame® standard sampling discs (CuDerm Corporation, Dallas, TX), which provide a standardized and reproducible method for obtaining superficial stratum corneum samples.[16] All volunteers provided consent for tape-strip collection in accordance with applicable ethical standards for research involving human participants.

Cleansers

Eight cleansers were evaluated, including GSC and 7 comparator cleansers. Selected comparator cleansers included those from established, dermatologist-recommended brands as well as newer, emerging formulas, and all had commercial claims or product labeling purporting to be gentle and/or used by individuals with sensitive skin. The comparator cleansers included Vanicream Gentle Facial Cleanser (VGC), BYOMA Milky Moisture Cleanser (BMC), La Roche-Posay Toleriane Hydrating Gentle Facial Cleanser (LRP), CeraVe Hydrating Facial Cleanser (CVC), Bubble Magic Melt (BMM), Neutrogena Ultra Gentle Hydrating Creamy Facial Cleanser (NCC), and Versed Hydrating Cream Cleanser (VCC). Each cleanser was prepared as a 10% aqueous solution (w/v) to ensure consistent surfactant exposure across all test articles and to reflect concentrations within the range employed in standard corneosurfametry protocols. A 5% aqueous solution of SLS was included as a positive control, representing a well-characterized harsh anionic surfactant known to induce significant stratum corneum disruption.[7,20] Deionized water was included as a negative control to establish baseline colorimetric values in the absence of surfactant exposure.

Corneosurfametry Methodology

The corneosurfametry procedure was conducted following a modified protocol adapted from previously published literature.[16,17] Five volar forearm D-Squame® tape strips were applied to each arm in duplicate; the first strip was discarded, and the second strip was retained for analysis.

Collected tape strips were submerged for 10 minutes in a 10% cleanser solution, 5% SLS, or water. After exposure, tapes were rinsed under cold running water for 30 seconds to remove residual test solution. Tapes were submerged in a toluidine blue–basic fuchsin staining solution for 3 minutes.[17] Following staining, tapes were rinsed again under cold running water for 30 seconds. Tapes were air-dried for 40 minutes before color assessment. Color measurements were obtained on a white background using a chromameter to enable reflectance colorimetry readout of staining intensity.[21]

Statistics and Photographic Analyses

The primary outcome was the CIM, derived from chromameter measurements, with a higher CIM interpreted as greater mildness (lighter staining) and a lower CIM indicating greater harshness (darker staining). Least-squares mean CIM values were estimated for each treatment condition, and pairwise comparisons versus GSC were used to determine statistical significance. Photographs of stained tapes were reviewed to assess qualitative concordance between tape appearance and CIM results.

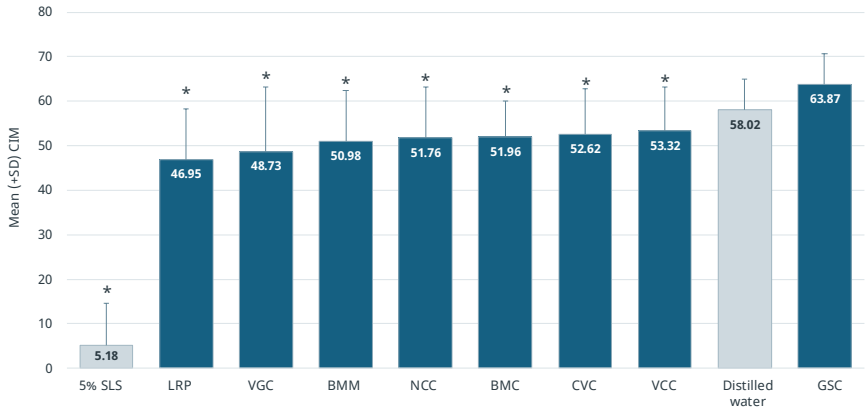
RESULTS

Colorimetric Index of Mildness

The average CIM values for all 8 test cleansers, the SLS positive control, and the water negative control are presented in Figure 1. Among the 8 cleanser products, GSC had the highest mean CIM (63.87), indicating the mildest surfactant–stratum corneum interaction under the assay conditions. Mean CIM values for comparator cleansers ranged from 46.95 (LRP) to 53.32 (VCC). Pairwise comparisons based on least-squares means indicated statistically significant differences between GSC and the comparator cleansers, supporting that GSC was significantly milder than the comparator cleansers under the assay conditions.

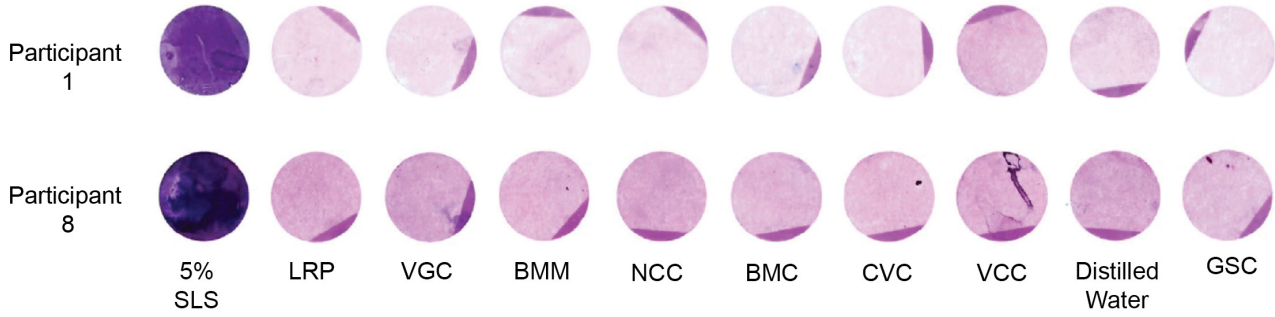
As expected, the 5% SLS positive control exhibited the lowest mean CIM value among all test articles, reflecting the well-established capacity of SLS to induce substantial stratum corneum protein denaturation and lipid disruption. All cleansers were statistically milder than SLS. Water produced a relatively high mean CIM (58.02), consistent with minimal surfactant-driven staining in the absence of detergent activity.

FIGURE 1. CIM across treatment conditions.



Mean CIM values (+SD) for each condition (GSC and 7 comparator cleansers, 5% SLS positive control, and water negative control) are shown (N=18). Higher CIM values indicate lighter staining and greater mildness (less surfactant–stratum corneum interaction) under the assay conditions. BMC, BYOMA Milky Moisture Cleanser; BMM, Bubble Magic Melt; CIM, colorimetric index of mildness; CVC, CeraVe Hydrating Facial Cleanser; GSC, Cetaphil® Gentle Skin Cleanser; LRP, La Roche-Posay Toleriane Hydrating Gentle Facial Cleanser; NCC, Neutrogena Ultra Gentle Hydrating Creamy Facial Cleanser; SLS, sodium lauryl sulfate; VCC, Versed Hydrating Cream Cleanser; VGC, Vanicream Gentle Facial Cleanser.

FIGURE 2. Representative stained tape outcomes following exposure and staining.



Representative photographs of stained D-Squame® tape strips following treatment with the test conditions (GSC, comparator cleansers, 5% SLS, and water). Darker staining indicates greater surfactant-induced alteration of the stratum corneum, whereas lighter staining indicates greater mildness. Representative images provide qualitative corroboration of the CIM-based ranking. BMC, BYOMA Milky Moisture Cleanser; BMM, Bubble Magic Melt; CIM, colorimetric index of mildness; CVC, CeraVe Hydrating Facial Cleanser; GSC, Cetaphil® Gentle Skin Cleanser; LRP, La Roche-Posay Toleriane Hydrating Gentle Facial Cleanser; NCC, Neutrogena Ultra Gentle Hydrating Creamy Facial Cleanser; SLS, sodium lauryl sulfate; VCC, Versed Hydrating Cream Cleanser; VGC, Vanicream Gentle Facial Cleanser.

Photographic Assessment

Representative photographic images of stained D-Squame® tapes from 2 participants are shown in Figure 2. SLS-exposed tapes appeared darkest, whereas GSC-exposed tapes appeared lighter relative to many comparator cleanser–exposed tapes. Visual inspection of the stained tapes revealed a clear gradient of coloration intensity that was consistent with the quantitative CIM data.

DISCUSSION

This project demonstrated that GSC was milder than selected comparator cleansers using a corneosurfametry assessment. Pairwise comparisons based on least-squares means indicated statistically significant differences between GSC and selected comparator cleansers, supporting that GSC was significantly milder under the assay conditions. This result is mechanistically consistent with evidence that surfactant-induced irritation is mediated by surfactant interactions with stratum corneum proteins and lipids.[4]

Corneosurfametry was originally described as an assay in which stratum corneum strippings were exposed to surfactants, stained with toluidine blue and basic fuchsin, and quantified by reflectance colorimetry.[17] In corneosurfametry, darker staining reflects greater surfactant-induced alteration of the stratum corneum, whereas lighter staining corresponds to greater mildness and higher CIM values.[17] The principle that darker tape coloration corresponds to harsher surfactant effects has been well established in the corneosurfametry literature and was clearly demonstrated in the present project.[17] Photographic assessment showed GSC-exposed tapes appeared lighter than all comparator cleanser-exposed tapes, consistent with the chromameter-derived CIM ranking of mildness.

Notably, GSC was numerically milder than water in its CIM value. It is possible that water itself may be irritating if components of the skin barrier are dissolved or disrupted in individuals with sensitive skin. These data further establish GSC's low-irritation potential.

Limitations of this project included enrolling healthy volunteers, only some of whom had sensitive skin, and the limited number of comparator cleansers. Additional investigations could explore the CIM of individuals with different Fitzpatrick skin types and different degrees of skin sensitivity. The products selected were also primarily intended for facial use, and corneosurfametry was performed on volar forearms.

Given that sensitive skin is defined by unpleasant sensations to ordinarily tolerated stimuli, minimizing cleansing-related barrier perturbation is a reasonable care objective.[22] These comparative mildness data are intended to support evidence-informed cleanser selection by patients and providers seeking an effective cleanser suitable for sensitive skin. Objective mildness profiling may aid clinicians in individualizing at-home skincare routines for patients with skin sensitivity.[15]

CONCLUSION

In this corneosurfametry assessment, GSC demonstrated mildness comparable to water, with the highest mean CIM and correspondingly lighter-stained tape appearance compared with the other gentle and/or hydrating cleansers evaluated. Overall, GSC had the lowest irritation potential, indicating its suitability for patients with sensitive skin. These findings also support corneosurfametry as a practical screening approach for differentiating among cleanser mildness levels and may help inform cleanser selection when gentle cleansing is desired in sensitive-skin routines.

DISCLOSURES

Sindhu Garimella MS, Thu Q. Nguyen PhD, Christine Emesiani PharmD, and Matthew Meckfessel PhD are employees of Galderma Laboratories, LP.

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